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C H A P. I.

Of Caterpillars in General.

IF we take a cursory view of insects in general, caterpillars alone, and the butterflies and moths they give birth to, will make a third part of the number. Wherever we move, wherever we turn, these insects, in one shape or another, present themselves to our view. Some, in every state, offer the most entertaining spectacle; others are beautiful only in their winged form. Many persons, of which number I am one, have an invincible aversion to caterpillars, and worms of every species: there is something disagreeable in their slow crawling motion, for which the variety of their colouring can never compensate. But others feel no repugnance at observing, and even handling them with the most attentive application.

There is nothing in the butterfly state, so beautiful or splendid as these insects. They serve, not less than the birds themselves, to banish solitude from our walks, and to fill up our idle intervals with the most pleasing speculations. The butterfly makes one of the principal ornaments of oriental poetry; but, in those countries, the insect is larger and more beautiful than with us.

The beauties of the fly may therefore very well excite our curiosity to examine the reptile. But we are still more strongly attached to this tribe, from the usefulness of one of the number. The silkworm is, perhaps, the most serviceable of all other animals; since, from its labours, and the manufacture attending it, near a third part of the world are clothed, adorned, and supported.

Caterpillars may be easily distinguished from worms or maggots, by the number of their feet; and by their producing butterflies or moths. When the sun calls up vegetation, and vivifies the various eggs of insects, the caterpillars are the first that are seen, upon almost every vegetable and tree, eating its leaves, and preparing for a state of greater perfection. They have feet both before and behind; which not only enable them to move forward by a sort of steps made by their fore and hinder parts, but also to climb up vegetables, and to stretch themselves out from
the

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the boughs and stalks, to reach their food at a distance. All of this class have from eight feet at the least, to sixteen ; and this may serve to distinguish them from the worm tribe, that never have so many. The animal into which they are converted, is always a butterfly or a moth ; and these are always distinguished from other flies, by having their wings covered over with a painted dust, which gives them such various beauty. The wings of flies are transparent, as we see in the common flesh fly ; while those of beetles are hard, like horn : from such the wing of a butterfly may be easily distinguished ; and words would obscure their differences.

From hence it appears, that caterpillars, whether in the reptile state, or advanced to their last state of perfection into butterflies, may easily be distinguished from all other insects ; being animals peculiarly formed, and also of a peculiar nature. The transmutations they undergo, are also more numerous than those of any insect hitherto mentioned ; and, in consequence, they have been placed in the third order of changes by Swammerdam, who has thrown such lights upon this part of natural history. In the second order of changes, mentioned before, we saw the grass-hopper and the earwig, when excluded from the egg, assume a form very like that which they were after to preserve ; and seemed
arrived

arrived at a state of perfection, in all respects, except in not having wings; which did not bud forth until they were come to maturity. But the insects of this third order, that we are now about to describe, go through a much greater variety of transformations: for, when they are excluded from the egg, they assume the form of a small caterpillar, which feeds and grows larger every day, often changing its skin, but still preserving its form. When the animal has come to a certain magnitude in this state, it discontinues eating, makes itself a covering or husk, in which it remains wrapped up, seemingly without life or motion; and after having for some time continued in this state, it once more bursts its confinement, and comes forth a beautiful butterfly. Thus we see this animal put on no less than three different appearances, from the time it is first excluded from the egg. It appears a crawling caterpillar; then an insensible aurelia, as it is called, without life or motion; and lastly, a butterfly, variously painted, according to its different kind. Having thus distinguished this class of insects from all others, we will first survey their history in general; and then enter particularly into the manners and nature of a few of them, which most deserve our curiosity and attention.

C H A P.

C H A P. II.

Of the Transformations of the Caterpillar into its corresponding Butterfly or Moth.

WHEN winter has disrobed the trees of their leaves, Nature then seems to have lost her insects. There are thousands of different kinds, with and without wings ; which, though swarming at other seasons, then entirely disappear. Our fields are re-peopled, when the leaves begin to bud, by the genial influence of spring ; and caterpillars, of various sorts, are seen feeding upon the promise of the year, even before the leaves are completely unfolded. Those caterpillars, which we then see, may serve to give us a view of the general means which Nature employs to preserve such a number of insects during that season, when they can no longer find subsistence. It is known, by united experience, that all these animals are hatched from the eggs of butterflies ; and those who observe them more closely, will find the fly very careful in depositing its eggs in those places where they are likely to be hatched with the greatest safety and success. During winter, therefore, the greatest number of caterpillars are in an egg state ; and in this lifeless situation, brave all the rigours

rigours and the humidity of the climate : and though often exposed to all its changes, still preserve the latent principles of life, which is more fully exerted at the approach of spring. That same power that pushes forth the budding leaf, and the opening flower, impels the insect into animation ; and Nature at once seems to furnish the guest and the banquet. When the insect has found force to break its shell, it always finds its favourite aliments provided in abundance before it.

But all caterpillars are not sent off from the egg in the beginning of spring ; for many of them have subsisted during the winter in their aurelia state : in which, as we have briefly observed above, the animal is seemingly deprived of life and motion. In this state of insensibility, many of these insects continue during the rigours of winter ; some enclosed in a kind of shell, which they have spun for themselves at the end of autumn ; some concealed under the bark of trees ; others in the chinks of old walls ; and many buried under ground. From all these, a variety of butterflies are seen to issue, in the beginning of spring ; and adorn the earliest part of the year with their painted flutterings,

Some caterpillars do not make any change whatsoever at the approach of winter, but continue

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tinue to live in their reptile state, through all the severity of the season. These chuse themselves some retreat, where they may remain undisturbed for some months together; and there they remain, quite motionless, and as insensible as if they were actually dead. Their constitution is such, that food, at that time, would be useless; and the cold prevents their making those dissipations which require restoration. In general, caterpillars of this kind are found in great numbers together, enclosed in one common web, that covers them all, and serves to protect them from the injuries of the air.

Lastly, there are some of the caterpillar kind, whose butterflies live all the winter; and who, having fluttered about for some part of the latter end of autumn, seek for some retreat during the winter, in order to answer the ends of propagation, at the approach of spring. These are often found lifeless and motionless in the hollows of trees, or the clefts of timber; but, by being carried to the fire, they recover life and activity, and seem to anticipate the desires of the spring.

In general, however, whether the animal has subsisted in an egg state, during the winter; or whether as a butterfly, bred from an aurelia, in the beginning of spring; or a butterfly

butterfly that has subsisted during the winter, and lays eggs as soon as the leaves of plants are shot forward, the whole swarm of caterpillars are in motion to share the banquet that Nature has provided. There is scarce a plant that has not its own peculiar insects; and some are known to support several of different kinds. Of these, many are hatched from the egg, at the foot of the tree, and climb up to its leaves for subsistence: the eggs of others, have been glued by the parent butterfly to the leaves: and they are no sooner excluded from the shell, but they find themselves in the midst of plenty.

When the caterpillar first bursts from the egg, it is small and feeble; its appetites are in proportion to its size, and it seems to make no great consumption: but as it encreases in magnitude, it improves in its appetites; so that, in its adult caterpillar state, it is the most ravenous of all animals whatsoever. A single caterpillar will eat double its own weight of leaves in a day, and yet seems no way disordered by the meal.—What would mankind do, if their oxen or their horses were so voracious?

These voracious habits, with its slow crawling motion, but still more a stinging like that of nettles, which follows upon handling the greatest number of them, make these insects not the most agreeable objects
of

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of human curiosity. However, there are many philosophers who have spent years in their contemplation ; and who have not only attended to their habits and labours, but minutely examined their structure and internal conformation.

The body of the caterpillar, when anatomically considered, is found composed of rings, whose circumference is pretty near circular or oval. They are generally twelve in number, and are all membraneous ; by which caterpillars may be distinguished from many other insects, that nearly resemble them in form. The head of the caterpillar is connected to the first ring by the neck ; that is generally so short and contracted, that it is scarce visible. All the covering of the head in caterpillars seems to consist of a shell ; and they have neither upper nor under jaw, for they are both placed rather vertically, and each jaw armed with a large thick tooth, which is singly equal to numbers. With these the animals devour their food in such amazing quantities ; and with these, some of the kind defend themselves against their enemies. Though the mouth be kept shut, the teeth are always uncovered ; and while the insect is in health, they are seldom without employment. Whatever the caterpillar devours, these teeth serve to chop
it

it into small pieces, and render the parts of the leaf fit for swallowing. Many kinds, while they are yet young, eat only the succulent part of the leaf, and leave all the fibres untouched; others, however, attack the whole leaf, and eat it clean away. One may be amused, for a little time, in observing the avidity with which they are seen to feed; some are seen eating the whole day; others have their hours of repast; some chuse the night, and others the day. When the caterpillar attacks a leaf, it places its body in such a manner that the edge of the leaf shall fall between its feet, which keeps it steady, while the teeth are employed in cutting it: these fall upon the leaf, somewhat in the manner of a pair of gardener's sheers; and every morsel is swallowed as soon as cut. Some caterpillars feed upon leaves so very narrow, that they are not broader than their mouths; in this case the animal is seen to devour it from the point, as we would eat a radish.

As there are various kinds of caterpillars, the numbers of their feet are various; some having eight, and some sixteen. Of these feet the six foremost are covered with a sort of shining gristle; and are therefore called the shelly legs. The hindmost feet, whatever be
their

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their number, are soft and flexible, and are called membranaceous. Caterpillars also, with regard to their external figure, are either smooth, or hairy. The skin of the first kind is soft to the touch, or hard, like shagreen; the skin of the latter, is hairy, and as it were thorny; and generally, if handled, stings like nettles. Some of them even cause this stinging pain, if but approached too nearly.

Caterpillars, in general, have six small black spots placed on the circumference of the fore ring, and a little to the side of the head. Three of these are larger than the rest, and are convex and transparent: these Reaumur takes to be the eyes of the caterpillar; however, most of these reptiles have very little occasion for sight, and seem only to be directed by their feeling.

But the parts of the caterpillar's body which most justly demand our attention, are the stigmata, as they are called; or those holes on the sides of its body, through which the animal is supposed to breathe. All along this insect's body, on each side, these holes are easily discoverable. They are eighteen in number, nine on a side, rather nearer the belly than the back; a hole for every ring, of which the animal's body is composed, except the second, the third, and the last. These oval openings
may

may be considered as so many mouths, through which the insect breathes; but with this difference, that as we have but one pair of lungs, the caterpillar has no less than eighteen. It requires no great anatomical dexterity to discover these lungs in the larger kind of caterpillars: they appear, at first view, to be hollow cartilaginous tubes, and of the colour of mother-of-pearl. These tubes are often seen to unite with each other; some are perceived to open into the intestines; and some go to different parts of the surface of the body. That these vessels serve to convey the air, appears evidently, from the famous experiment of Malpighi; who, by stopping up the mouths of the stigmata with oil, quickly suffocated the animal, which was seen to die convulsed the instant after. In order to ascertain his theory, he rubbed oil upon other parts of the insect's body, leaving the stigmata free; and this seemed to have no effect upon the animal's health, but it continued to move and eat as usual: he rubbed oil on the stigmata of one side, and the animal underwent a partial convulsion, but recovered soon after. However, it ought to be observed, that air is not so necessary to these as to the nobler ranks of animals, since caterpillars will live in an exhausted receiver for several days together; and though they seem dead
at

at the bottom, yet, when taken out, recover, and resume their former vivacity.

If the caterpillar be cut open longitudinally along the back, its intestines will be perceived running directly in a straight line from the mouth to the anus. They resemble a number of small bags opening into each other; and strengthened on both sides by a fleshy cord, by which they are united. These insects are, upon many occasions, seen to cast forth the internal coat of their intestines with their food, in the changes which they so frequently undergo. But the intestines take up but a small part of the animal's body, if compared to the fat substance in which they are involved. This substance changes its colour when the insect's metamorphosis begins to approach; and from white it is usually seen to become yellow. If to these parts, we add the caterpillar's implements for spinning, (for all caterpillars spin at one time or another) we shall have a rude sketch of this animal's conformation: however, we shall reserve the description of those parts, till we come to the history of the silk-worm, where the manner in which these insects spin their webs, will most properly find place.

The life of a caterpillar seems one continued succession of changes; and it is seen to throw off
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one skin only to assume another; which also is divested in its turn: and thus for eight or ten times successively. We must not, however confound this changing of the skin with the great metamorphosis which it is afterwards to undergo. The throwing off one skin, and assuming another, seems, in comparison, but a slight operation among these animals: this is but the work of a day; the other is the great adventure of their lives. Indeed, this faculty of changing the skin, is not peculiar to caterpillars only, but is common to all the insect kind; and even to some animals that claim a higher rank in nature. We have already seen the lobster and the crab out-growing their first shells, and then bursting from their confinement, in order to assume a covering more roomy and convenient. It is probable that the louse, the flea, and the spider, change their covering from the same necessity; and growing too large for the crust in which they have been for some time enclosed, burst it for another. This period is probably that of their growth; for as soon as their new skin is hardened round them, the animal's growth is necessarily circumscribed, while it remains within it. With respect to caterpillars, many of them change their skins five or six times in a season; and
this

this covering, when cast off, often seems so complete, that many might mistake the empty skin for the real insect. Among the hairy caterpillars, for instance, the cast skin is covered with hair; the feet, as well gristly as membranous, remain fixed to it; even the parts which nothing but a microscope can discover, are visible in it; in short, all the parts of the head; not only the skull, but the teeth.

In proportion as the time approaches in which the caterpillar is to cast its old skin, its colours become more feeble, the skin seems to wither and grow dry, and in some measure resembles a leaf, when it is no longer supplied with moisture from the stock. At that time, the insect begins to find itself under a necessity of changing; and it is not effected without violent labour, and perhaps pain. A day or two before the critical hour approaches, the insect ceases to eat, loses its usual activity, and seems to rest immovable. It seeks some place to remain in security; and no longer timorous, seems regardless even of the touch. It is now and then seen to bend itself and elevate its back; again it stretches to its utmost extent: it sometimes lifts up the head, and then lets it fall again; it sometimes waves it three or four times from side to side, and then remains in quiet.

At length, some of the rings of its body, particularly the first and second, are seen to swell considerably, the old skin distends and bursts, till, by repeated swellings and contractions in every ring, the animal disengages itself, and creeps from its inconvenient covering.

How laborious soever this operation may be, it is performed in the space of a minute; and the animal, having thrown off its old skin, seems to enjoy new vigour, as well as acquired colouring and beauty. Sometimes it happens, that it takes a new appearance, and colours very different from the old. Those that are hairy, still preserve their covering; although their ancient skin seems not to have lost a single hair: every hair appears to have been drawn, like a sword from the scabbard. However, the fact is, that a new crop of hair grows between the old skin and the new, and probably helps to throw off the external covering.

The caterpillar having in this manner continued for several days feeding, and at intervals casting its skin, begins at last to prepare for its change into an aurelia. It is most probable that, from the beginning, all the parts of the butterfly lay hid in this insect, in its reptile state; but it required time to bring them to perfection; and a large quantity of food, to enable the animal

to

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to undergo all the changes requisite for throwing off these skins, which seemed to clog the butterfly form. However, when the caterpillar has fed sufficiently, and the parts of the future butterfly have formed themselves beneath its skin, it is then time for it to make its first great and principal change into an aurelia, or a chrysalis, as some have chosen to call it; during which, as was observed, it seems to remain for several days, or even months, without life or motion.

Preparatory to this important change, the caterpillar most usually quits the plant, or the tree on which it fed; or at least attaches itself to the stalk or the stem, more gladly than the leaves. It forsakes its food, and prepares, by fasting, to undergo its transmutation. In this period, all the food it has taken is thoroughly digested; and it often voids even the internal membrane which lined its intestines. Some of this tribe, at this period also, are seen entirely to change colour; and the vivacity of the tints in all, seem faded. Those of them which are capable of spinning themselves a web, set about this operation; those which have already spun, await the change in the best manner they are able. The web or cone, with which some cover themselves, hides the aurelia contained within from the

view ; but in others, where it is more transparent, the caterpillar, when it has done spinning, strikes into it the claws of the two feet under the tail, and afterwards forces in the tail itself, by contracting those claws, and violently striking the feet one against the other. If, however, they may be taken from their web at this time, they appear in a state of great languor ; and, incapable of walking, remain on that spot where they are placed. In this condition they remain one or two days, preparing to change into an aurelia ; somewhat in the manner they made preparations for changing their skin. They then appear with their bodies bent into a bow, which they now and then are seen to straiten : they make no use of their legs ; but if they attempt to change place, do it by the contortions of their body. In proportion as their change into an aurelia approaches, their body becomes more and more bent ; while their extensions and convulsive contractions become more frequent. The hinder end of the body is the part which the animal first disengages from its caterpillar skin ; that part of the skin remains empty, while the body is drawn up contractedly towards the head. In the same manner they disengage themselves from the two succeeding rings ; so that the animal is then lodged entirely in
the

the fore part of its caterpillar covering : that half which is abandoned, remains flaccid and empty ; while the fore part, on the contrary, is swollen and distended. The animal, having thus quitted the hinder part of its skin, to drive itself up into the fore part, still continues to heave and work as before ; so that the skull is soon seen to burst into three pieces, and a longitudinal opening is made in the three first rings of the body, through which the insect thrusts forth its naked body, with strong efforts. Thus at last, it entirely gets free from its caterpillar skin, and for ever forsakes its most odious reptile form.

The caterpillar, thus stripped of its skin for the last time, is now become an aurelia ; in which the parts of the future butterfly are all visible ; but in so soft a state, that the smallest touch can discompose them. The animal is now become helpless and motionless ; but only waits for the assistance of the air to dry up the moisture on its surface, and supply it with a crust capable of resisting external injuries. Immediately after being stripped of its caterpillar skin, it is of a green colour, especially in those parts which are distended by an extraordinary afflux of animal moisture ; but in ten or twelve hours after being thus exposed, its parts harden, the air forms its external covering

covering into a firm crust, and in about four and twenty hours, the aurelia may be handled without endangering the little animal that is thus left in so defenceless a situation. Such is the history of the little pod or cone that is found so common by every path-way, sticking to nettles, and sometimes shining like polished gold. From the beautiful and resplendent colour, with which it is thus sometimes adorned, some authors have called it a Chrysalis, implying a creature made of gold.

Such are the efforts by which these little animals prepare for a state of perfection; but their care is still greater to provide themselves a secure retreat, during this season of their imbecility. It would seem like erecting themselves a monument, where they were to rest secure, until Nature had called them into a new and more improved existence. For this purpose, some spin themselves a cone or web, in which they lie secure till they have arrived at maturity: others, that cannot spin so copious a covering, suspend themselves by the tail, in some retreat where they are not likely to meet disturbances. Some mix sand with their gummy and moist webs, and thus make themselves a secure incrustation; while others, before their change, bury themselves in the ground, and thus avoid the
numerous

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numerous dangers that might attend them. One would imagine that they were conscious of the precise time of their continuance in their aurelia state; since their little sepulchres, with respect to the solidity of the building, are proportioned to such duration. Those that are to lie in that state of existence but a few days, make choice of some tender leaf, which they render still more pliant by diffusing a kind of glue upon it: the leaf thus gradually curls up, and withering as it enfolds, the insect wraps itself within, as in a mantle, till the genial warmth of the sun enables it to struggle for new life, and burst from its confinement. Others, whose time of transformation is also near at hand, fasten their tails to a tree, or to the first worm-hole they meet, in a beam, and wait in that defenceless situation. Such caterpillars, on the other hand, as are seen to lie several months in their aurelia state, act with much greater circumspection. Most of them mix their web with sand, and thus make themselves a strong covering: others build in wood, which serves them in the nature of a coffin. Such as have made the leaves of willows their favourite food, break the tender twigs of them first into small pieces, then pound them as it were to powder; and, by means of their glutinous silk, make a
kind

kind of paste, in which they wrap themselves up. Many are the forms which these animals assume in this helpless state; and it often happens, that the most deformed butterflies issue from the most beautiful aurelias.

In general, however, the aurelia takes the rude outline of the parts of the animal which is contained within it; but as to the various colours which it is seen to assume, they are rather the effect of accident; for the same species of insect does not at all times assume the same hue, when it becomes an aurelia. In some, the beautiful gold colour is at one time found; in others, it is wanting. This brilliant hue, which does not fall short of the best gilding, is formed in the same manner in which we see leather obtain a gold colour, though none of that metal ever enters into the tincture. It is only formed by a beautiful brown varnish, laid upon a white ground; and the white thus gleaming through the transparency of the brown, gives a charming golden yellow. These two colours are found, one over the other, in the aurelia of the little animal we are describing; and the whole appears gilded, without any real gilding.

The aurelia thus formed, and left to time to expand into a butterfly, in some measure resembles

resembles an animal in an egg, that is to wait for external warmth to hatch it into life and vigour. As the quantity of moisture that is enclosed within the covering of the aurelia, continues to keep its body in the most tender state, so it is requisite that this humidity should be dried away, before the little butterfly can burst its prison. Many have been the experiments to prove that nature may in this respect be assisted by art ; and that the life of the insect may be retarded or quickened, without doing it the smallest injury. For this purpose, it is only requisite to continue the insect in its aurelia state, by preventing the evaporation of its humidity ; which will consequently add some days, nay weeks, to its life : on the other hand, by evaporating its moisture, in a warm situation, the animal assumes its winged state before its usual time, and goes through the offices assigned its existence. To prove this, Mr. Reaumur enclosed the aurelia in a glass tube ; and found the evaporated water, which exhaled from the body of the insect, collected in drops at the bottom of the tube : he covered the aurelia with varnish ; and this making the evaporation more difficult and slow, the butterfly was two months longer than its natural term, in coming out of its case ; he found, on the other hand, that

that by laying the animal in a warm room, he hastened the disclosure of the butterfly ; and by keeping it in an ice-house in the same manner, he delayed it. Warmth acted, in this case, in a double capacity ; invigorating the animal, and evaporating the moisture.

The aurelia, though it bears a different external appearance, nevertheless contains within it all the parts of the butterfly in perfect formation ; and lying each in a very orderly manner, though in the smallest compass. These, however, are so fast and tender, that it is impossible to visit without discomposing them. When either by warmth, or encreasing vigour, the parts have acquired the necessary force and solidity, the butterfly then seeks to disembarraßs itself of those bands which kept it so long in confinement. Some insects continue under the form of an aurelia not above ten days ; some twenty ; some several months ; and even for a year together.

The butterfly, however, does not continue so long under the form of an aurelia, as one would be apt to imagine. In general, those caterpillars that provide themselves with cones, continue within them but a few days after the cone is completely finished. Some, however, remain buried in this artificial covering for eight
or

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or nine months, without taking the smallest sustenance during the whole time : and though in the caterpillar state no animals were so voracious, when thus transformed, they appear a miracle of abstinence. In all, sooner or later, the butterfly bursts from its prison ; not only that natural prison which is formed by the skin of the aurelia, but also from that artificial one of silk, or any other substance in which it has enclosed itself.

The efforts which the butterfly makes to get free from its aurelia state, are by no means so violent as those which the insect had in changing from the caterpillar into the aurelia. The quantity of moisture surrounding the butterfly is by no means so great as that attending its former change ; and the shell of the aurelia is so dry, that it may be cracked between the fingers.

If the animal be shut up within a cone, the butterfly always gets rid of the natural internal skin of the aurelia, before it eats its way through the external covering which its own industry has formed round it. In order to observe the manner, in which it thus gets rid of the aurelia covering, we must cut open the cone, and then we shall have an opportunity of discovering the insect's efforts to emancipate itself from its natural shell. When this operation begins, there seems to
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be a violent agitation in the humours contained within the little animal's body. Its fluids seem driven, by an hasty fermentation, through all the vessels; while it labours violently with its legs, and makes several other violent struggles to get free. As all these motions concur with the growth of the insect's wings and body, it is impossible that the brittle skin which covers it should longer resist: it at length gives way, by bursting into four distinct and regular pieces. The skin of the head and legs first separates; then the skin at the back flies open, and dividing into two regular portions, disengages the back and wings: then there likewise happens another rupture in that portion which covered the rings of the back of the aurelia. After this, the butterfly, as if fatigued with its struggles, remains very quiet for some time, with its wings pointed downwards, and its legs fixed in the skin which it had just thrown off. At first sight the animal, just set free, and permitted the future use of its wings, seems to want them entirely: they take up such little room, that one would wonder where they were hidden. But soon after, they expand so rapidly, that the eye can scarce attend their unfolding. From reaching scarce half the length of the body, they acquire, in a most wonderful manner, their full extent and bigness, so as
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to be each five times larger than they were before. Nor is it the wings alone that are thus encreased : all their spots and paintings, before so minute as to be scarce discernible, are proportionably extended ; so that, what a few minutes before seemed only a number of confused, unmeaning points, now become distinct and most beautiful ornaments. Nor are the wings, when they are thus expanded, unfolded in the manner in which earwigs and grasshoppers display theirs, who unfurl them like a lady's fan : on the contrary, those of butterflies actually grow to their natural size in this very short space. The wing, at the instant it is freed from its late confinement, is considerably thicker than afterwards ; so that it spreads in all its dimensions, growing thinner as it becomes broader. If one of the wings be plucked from the animal just set free, it may be spread by the fingers, and it will soon become as broad as the other, which has been left behind. As the wings extend themselves so suddenly, they have not yet had time to dry ; and accordingly appear like pieces of wet [paper, soft, and full of wrinkles. In about half an hour, they are perfectly dry, their wrinkles entirely disappear, and the little animal assumes all its splendor. The transmutation being thus perfectly finished,

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the butterfly discharges three or four drops of a blood-coloured liquid, which are the last remains of its superfluous moisture. Those aurelias which are enclosed within a cone, find their exit still more difficult, as they have still another prison to break through: this, however, they perform in a short time; for the butterfly, freed from its aurelia skin, butts with its head violently against the walls of its artificial prison; and probably with its eyes, that are rough and like a file, it rubs the internal surface away; till it is at last seen bursting its way into open light; and, in less than a quarter of an hour, the animal acquires its full perfection.

Thus, to use the words of Swammerdam, we see a little insignificant creature distinguished, in its last birth, with qualifications and ornaments, which man, during his stay upon earth, can never even hope to acquire. The butterfly, to enjoy life, needs no other food but the dews of Heaven; and the honeyed juices which are distilled from every flower. The pageantry of princes cannot equal the ornaments with which it is invested; nor the rich colouring that embellishes its wings. The skies are the butterfly's proper habitation, and the air its element: whilst man comes into the world naked, and often roves about without
habitation

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habitation or shelter ; exposed, on one hand, to the heat of the sun ; and on the other, to the damps and exhalations of the earth ; both alike enemies of his happiness and existence.—A strong proof that, while this little animal is raised to its greatest height, we are as yet, in this world, only candidates for perfection !



C H A P.

C H A P. III.

Of Butterflies and Moths.

IT has been already shewn that all Butterflies are bred from caterpillars ; and we have exhibited the various circumstances of that surprizing change. It has been remarked, that butterflies may be easily distinguished from flies of every other kind, by their wings ; for, in others, they are either transparent, like gauze, as we see in the common flesh fly ; or they are hard and crufted, as we see in the wings of the beetle. But in the butterfly, the wings are soft, opake, and painted over with a beautiful duft, that comes off with handling.

The number of these beautiful animals is very great ; and though Linnæus has reckoned up above seven hundred and fixty different kinds, the catalogue is still very incomplete. Every collector of butterflies can shew undescribed species : and such as are fond of minute discovery, can here produce animals that have been examined only by himself. In general, however, those of the warm climates, are larger and more beautiful than such as are bred at home ; and we can easily admit the beauty of the

the butterfly, since we are thus freed from the damage of the caterpillar. It has been the amusement of some to collect these animals, from different parts of the world ; or to breed them from caterpillars at home. These they arrange in systematic order ; or dispose so as to make striking and agreeable pictures : and all must grant, that this specious idleness is far preferable to that unhappy state which is produced by a total want of employment.

The wings of butterflies, as was observed, fully distinguish them from flies of every other kind. They are four in number ; and though two of them be cut off, the animal can fly with the two others remaining. They are, in their own substance, transparent ; but owe their opacity to the beautiful dust with which they are covered ; and which has been likened, by some naturalists, to the feathers of birds ; by others, to the scales of fishes ; as their imaginations were disposed to catch the resemblance. In fact, if we regard the wing of a butterfly with a good microscope, we shall perceive it studded over with a variety of little grains of different dimensions and forms, generally supported upon a footstalk, regularly laid upon the whole surface. Nothing can exceed the beautiful and regular arrangement of these

little substances; which thus serve to paint the butterfly's wing, like the tiles of an house. Those of one rank are a little covered by those that follow: they are of many figures: on one part of the wing may be seen a succession of oval studs; on another part, a cluster of studs, each in the form of an heart: in one place they resemble a hand open; and in another they are long or triangular; while all are interspersed with taller studs, that grow between the rest, like mushrooms upon a stalk. The wing itself is composed of several thick nerves, which render the construction very strong, though light; and though it be covered over with thousands of these scales or studs, yet its weight is very little increased by the number. The animal is with ease enabled to support itself a long while in air, although its flight be not very graceful. When it designs to fly to a considerable distance, it ascends and descends alternately; going sometimes to the right, sometimes to the left, without any apparent reason. Upon closer examination, however, it will be found that it flies thus irregularly in pursuit of its mate; and as dogs bait and quarter the ground in pursuit of their game, so these insects traverse the air, in quest of their mates, whom they can discover at more than a mile's distance.

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If we prosecute our description of the butterfly, the animal may be divided into three parts; the head, the corselet, and the body.

The body is the hinder part of the butterfly, and is composed of rings, which are generally concealed under long hair, with which that part of the animal is clothed. The corselet is more solid than the rest of the body, because the fore wings, and the legs, are fixed therein. The legs are six in number, although four only are made use of by the animal; the two fore legs being often so much concealed in the long hair of the body, that it is sometimes difficult to discover them. If we examine these parts internally, we shall find the same set of vessels in the butterfly that we observed in the caterpillar, but with this great difference; that as the blood, or humours, in the caterpillar, circulated from the tail to the head, they are found, in the butterfly, to take a direct contrary course, and to circulate from the head to the tail; so that the caterpillar may be considered as the embryo animal, in which, as we have formerly seen, the circulation is carried on differently from what it is in animals when excluded.

But leaving the other parts of the butterfly, let us turn our attention particularly to the head. The eyes of butterflies have not

all the same form ; for, in some they are large, in others small ; in some they are the larger portion of a sphere, in others they are but a small part of it, and just appearing from the head. In all of them, however, the outward coat has a lustre, in which may be discovered the various colours of the rainbow. When examined a little closely, it will be found to have the appearance of a multiplying glass ; having a great number of sides, or facets, in the manner of a brilliant cut diamond. In this particular, the eye of the butterfly, and of most other insects, entirely correspond ; and Luenhoek pretends, there are above six thousand facets on the cornea of a flea. These animals, therefore, see not only with great clearness ; but view every object multiplied in a surprizing manner. Puget adapted the cornea of a fly in such a position, as to see objects through it by the means of a microscope ; and nothing could exceed the strangeness of its representations : a soldier, who was seen through it appeared like an army of pigmies ; for while it multiplied, it also diminished the object : the arch of a bridge exhibited a spectacle more magnificent than human skill could perform ; the flame of a candle seemed a beautiful illumination. It still, however, remains a doubt, whether

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whether the insect sees objects singly, as with one eye; or whether every facet is itself a complete eye, exhibiting its own object distinct from all the rest.

Butterflies, as well as most other flying insects, have two instruments, like horns, on their heads, which are commonly called feelers. They differ from the horns of greater animals, in being moveable at their base, and in having a great number of joints, by which means the insect is enabled to turn them in every direction. Those of butterflies are placed at the top of the head, pretty near the external edge of each eye. What the use of these instruments may be, which are thus formed with so much art, and by a Workman who does nothing without reason, is as yet unknown to man. They may serve to guard the eye; they may be of use to clean it; or they may be the organ of some sense which we are ignorant of: but this is only explaining one difficulty by another.

We are not so ignorant of the uses of the trunk, which few insects of the butterfly kind are without. This instrument is placed exactly between the eyes; and when the animal is not employed in seeking its nourishment, it is rolled up, like a curl. A butterfly, when it is feeding, flies round some flower, and settles upon it. The trunk is then uncurled, and thrust out either wholly or in part: and

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is employed in searching the flower to its very bottom, let it be ever so deep. This search being repeated seven or eight times, the butterfly then passes to another ; and continues to hover over those agreeable to its taste, like a bird over its prey. This trunk consists of two equal hollow tubes, nicely joined to each other, like the pipes of an organ.

Such is the figure and conformation of these beautiful insects, that cheer our walks, and give us the earliest intimations of summer. But it is not by day alone that they are seen fluttering wantonly from flower to flower, as the greatest number of them fly by night, and expand the most beautiful colouring, at those hours when there is no spectator. This tribe of insects has therefore been divided into Diurnal and Nocturnal Flies ; or, more properly speaking, into Butterflies and Moths : the one only flying by day, the other most usually on the wing in the night. They may be easily distinguished from each other, by their horns or feelers : those of the butterfly being clubbed, or knobbed at the end ; those of the moth, tapering finer and finer to a point. To express it technically—the feelers of butterflies are clavated ; those of moths are filiform.

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BUTTERFLIES AND MOTHS. 39

The butterflies, as well as the moths, employ the short life assigned them, in a variety of enjoyments. Their whole time is spent either in quest of food, which every flower offers; or in pursuit of the female, whose approach they can often perceive at above two miles distance. Their sagacity in this particular is not less astonishing than true; but by what sense they are thus capable of distinguishing each other at such distances, is not easy to conceive. It cannot be by the sight, since such small objects as they are must be utterly imperceptible, at half the distance at which they perceive each other: it can scarcely be by the sense of smelling, since the animal has no organs for that purpose. Whatever be their powers of perception, certain it is, that the male, after having fluttered, as if carelessly, about for some time, is seen to take wing, and go forward, sometimes for two miles together, in a direct line to where the female is perched on a flower.

The general rule among insects is, that the female is larger than the male; and this obtains particularly in the tribe I am describing. The body of the male is smaller and slenderer; that of the female, more thick and oval. Previous to the junction of these animals, they are seen sporting in the air, pursuing and flying from each other, and
preparing,

preparing, by a mock combat, for the more important business of their lives. If they be disturbed while united, the female flies off with the male on her back, who seems entirely passive upon the occasion.

But the females of many moths and butterflies seem to have assumed their airy form for no other reason but to fecundate their eggs, and lay them. They are not seen fluttering about in quest of food, or a mate: all that passes, during their short lives, is a junction with the male of about half an hour; after which they deposite their eggs, and die, without taking any nourishment, or seeking any. It may be observed, however, that in all the females of this tribe, they are impregnated by the male by one aperture, and lay their eggs by another.

The eggs of female butterflies are disposed in the body like a bed of chaplets; which, when excluded, are usually oval, and of a whitish colour: some, however, are quite round; and others flatted, like a turnip. The covering or shell of the egg, though solid, is thin and transparent; and in proportion as the caterpillar grows within the egg, the colours change, and are distributed differently. The butterfly seems very well instructed by nature in its choice of the plant, or the leaf, where it shall deposite its burthen. Each egg contains but one caterpillar;

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pillar and it is requisite that this little animal, when excluded, should be near its peculiar provision. The butterfly, therefore, is careful to place her brood only upon those plants that afford good nourishment to its posterity. Though the little winged animal has been fed itself upon dew, or the honey of flowers, yet it makes choice for its young of a very different provision, and lays its eggs on the most unfavourable plants; the ragweed, the cabbage, or the nettle. Thus every butterfly chuses not the plant most grateful to it in its winged state; but such as it has fed upon in its reptile form.

All the eggs of butterflies are attached to the leaves of the favourite plant, by a sort of size or glue; where they continue, unobserved, unless carefully sought after. The eggs are sometimes placed round the tender shoots of plants, in the form of bracelets, consisting of above two hundred in each, and generally surrounding the shoot, like a ring upon the finger. Some butterflies secure their eggs from the injuries of air, by covering them with hair, plucked from their own bodies, as birds sometimes are seen to make their nests; so that their eggs are thus kept warm, and also entirely concealed.

All the tribe of female moths lay their eggs a short time after they leave the aurelia; but there are many butterflies that flutter
about

about the whole summer, and do not think of laying, till the winter begins to warn them of their approaching end : some even continue the whole winter in the hollows of trees, and do not provide for posterity until the beginning of April, when they leave their retreats, deposite their eggs, and die. Their eggs soon begin to feel the genial influence of the season : the little animals burst from them in their caterpillar state, to become aurelias, and butterflies in their turn ; and thus to continue the round of nature.



CHAP.

C H A P. IV.

Of the Enemies of the Caterpillar.

NATURE, though it has rendered some animals surprizingly fruitful, yet ever takes care to prevent their too great encrease. One set of creatures is generally opposed to another: and those are chiefly the most prolific, that are, from their imbecility, incapable of making any effectual defence. The caterpillar has perhaps, of all other animals, the greatest number of enemies; and seems only to exist, by its surprizing fecundity. Some animals devour them by hundreds; others, more minute, yet more dangerous, mangle them in various ways: so that, how great soever their numbers may be, their destroyers are in equal proportion. Indeed, if we consider the mischiefs these reptiles are capable of occasioning, and the various damages we sustain from their insatiable rapacity, it is happy for the other ranks of nature, that there are thousands of fishes, birds, and even insects, that live chiefly upon caterpillars, and make them their most favourite repast.

When we described the little birds that live in our gardens, and near our houses,
as

as destructive neighbours, sufficient attention was not paid to the services which they are frequently found to render us. It has been proved, that a single sparrow and its mate, that have young ones, destroy above three thousand caterpillars in a week; not to mention several butterflies, in which numberless caterpillars are destroyed in embryo. It is in pursuit of these reptiles that we are favoured with the visits of many of our most beautiful songsters; that amuse us during their continuance, and leave us when the caterpillars disappear.

The maxim which has often been urged against man, that he, of all other animals, is the only creature that is an enemy to his own kind, and that the human species only are found to destroy each other, has been adopted, by persons who never considered the history of insects. Some of the caterpillar kind in particular, that seem fitted only to live upon leaves and plants, will, however, eat each other; and the strongest will devour the weak, in preference to their vegetable food. That which lives upon the oak, is found to seize any of its companions, which it conveniently can, by the first rings, and inflict a deadly wound: it then feasts in tranquillity on its prey, and leaves nothing of the animal but the husk.

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But it is not from each other they have most to fear, as in general they are inoffensive; and many of this tribe are found to live in a kind of society. Many kinds of flies lay their eggs either upon, or within their bodies; and as these turn into worms, the caterpillar is seen to nourish a set of intestine enemies within its body, that must shortly be its destruction: Nature having taught flies, as well as all other animals, the surest methods of perpetuating their kind. "Towards the end of August," says Reaumur, "I perceived a little fly, of a beautiful gold colour, busily employed in the body of a large caterpillar, of that kind which feeds upon cabbage. I gently separated that part of the leaf on which these insects were placed, from the rest of the plant, and placed it where I might observe them more at my ease. The fly, wholly taken up by the business in which it was employed, walked along the caterpillar's body, now and then remaining fixed to a particular spot. Upon this occasion, I perceived it every now and then dart a sting, which it carried at the end of its tail, into the caterpillar's body, and then drew it out again, to repeat the same operation in another place. It was not difficult for me to conjecture the business which engaged this animal so earnestly ;
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“ its whole aim was to deposite its eggs in
“ the caterpillar’s body ; which was to serve
“ as a proper retreat for bringing them to
“ perfection. The reptile thus rudely treat-
“ ed, seemed to bear all very patiently, only
“ moving a little when stung too deeply ;
“ which, however, the fly seemed entirely to
“ disregard. I took particular care to feed
“ this caterpillar ; which seemed to me to
“ continue as voracious and vigorous as any
“ of the rest of its kind. In about ten or
“ twelve days, it changed into an aurelia,
“ which seemed gradually to decline, and
“ died : upon examining its internal parts,
“ the animal was entirely devoured by
“ worms ; which however, did not come to
“ perfection, as it is probable they had
“ not enough to sustain them within.”

What the French philosopher perceived upon this occasion, is every day to be seen in several of the larger kind of caterpillars, whose bodies serve as a nest to various flies, that very carefully deposite their eggs within them. The large cabbage caterpillar is so subject to its injuries, that, at certain seasons, it is much easier to find them with than without them. The ichneumon fly, as it is called, particularly infests these reptiles, and prevents their fecundity. This fly is, of all others, the most formidable to insects
of

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of various kinds. The spider, that destroys the ant, the moth, and the butterfly, yet often falls a prey to the ichneumon ; who pursues the robber to his retreat, and, despising his nets, tears him in pieces, in the very labyrinth he has made. This insect, as redoubtable as the little quadrupede that destroys the crocodile, has received the same name ; and from its destruction of the caterpillar tribe, is probably more serviceable to mankind. This insect, I say, makes the body of the caterpillar the place for depositing its eggs ; to the number of ten, fifteen, or twenty. As they are laid in those parts which are not mortal, the reptile still continues to live, and to feed, shewing no signs of being incommoded by its new guests. The caterpillar changes its skin, and sometimes undergoes the great change into an aurelia : but still the fatal intruders work within, and secretly devour its internal substance : soon after they are seen bursting through its skin, and moving away, in order to spin themselves a covering, previous to their own little transformation. It is indeed astonishing sometimes to see the number of worms, and those pretty large, that thus issue from the body of a single caterpillar, and eat their way through its skin : but it is more extraordinary still, that they should remain within the body, devouring its entrails,

trails, without destroying its life. The truth is, they seem instructed by nature not to devour its vital parts; for they are found to feed only upon that fat substance which composes the largest part of the caterpillar's body. When this surprizing appearance was first observed, it was supposed that the animal thus gave birth to a number of flies, different from itself; and that the same caterpillar sometimes bred an ichneumon, and sometimes a butterfly; but it was not till after a more careful inspection, it was discovered, that the ichneumon tribe were not the caterpillar's offspring, but its murderers.



C H A P.

C H A P. V.

Of the Silkworm.

HAVING mentioned, in the last chapter, the damages inflicted by the caterpillar tribe, we now come to an animal of this kind, that alone compensates for all the mischief occasioned by the rest. This little creature, which only works for itself, has been made of the utmost service to man; and furnishes him with a covering more beautiful than any other animal can supply. We may declaim indeed against the luxuries of the times, when silk is so generally worn; but were such garments to fail, what other arts could supply their deficiency?

Though silk was anciently brought in small quantities to Rome, yet it was so scarce as to be sold for its weight in gold; and was considered as such a luxurious refinement in dress, that it was infamous for a man to appear in habits of which silk formed but half the composition. It was most probably brought among them from the remotest parts of the east; since it was, at the time of which I am speaking, scarcely known even in Persia.

Nothing can be more remote from the truth, than the manner in which their historians describe the animal by which silk is produced. Pausanias informs us, that silk came from the country of the Seres, a people of Asiatic Scythia; in which place an insect, as large as the beetle, but in every other respect resembling a spider, was bred up for that purpose. They take great care, as he assures us, to feed and defend it from the weather; as well during the summer's heat, as the rigours of winter. This insect, he observes, makes its web with its feet, of which it has eight in number. It is fed, for the space of four years, upon a kind of paste, prepared for it; and at the beginning of the fifth, it is supplied with the leaves of the green willow, of which it is particularly fond. It then feeds till it bursts with fat; after which they take out its bowels, which are spun into the beautiful manufacture so scarce and costly.

The real history of this animal was unknown among the Romans till the times of Justinian; and it is supposed, that silkworms were not brought into Europe till the beginning of the twelfth century; when Roger of Sicily, brought workmen in this manufacture from Asia Minor, after his return from his expedition to the Holy Land, and settled them in Sicily and Calabria. From these
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the other kingdoms of Europe learned this manufacture; and it is now one of the most lucrative carried on among the southern provinces of Europe.

The silkworm is now very well known to be a large caterpillar, of a whitish colour, with twelve feet, and producing a butterfly of the moth kind. The cone on which it spins, is formed for covering it while it continues in the aurelia state; and several of these, properly wound off, and united together, form those strong and beautiful threads, which are woven into silk. The feeding these worms, the gathering, the winding, the twisting, and the weaving their silk, is one of the principal manufactures of Europe; and, as our luxuries encrease, seems every day to become more and more necessary to human happiness.

There are two methods of breeding silkworms; for they may be left to grow, and remain at liberty upon the trees where they are hatched; or they may be kept in a place built for that purpose, and fed every day with fresh leaves. The first method is used in China, Tonquin, and other hot countries; the other is used in those places where the animal has been artificially propagated, and still continues a stranger. In the warm climates, the silkworm proceeds from an egg, which has been glued by the parent

moth upon proper parts of the mulberry-tree, and which remains in that situation during the winter. The manner in which they are situated and fixed to the tree, keeps them unaffected by the influence of the weather; so that those frosts which are severe enough to kill the tree, have no power to injure the silkworm.

The insect never proceeds from the egg till Nature has provided it a sufficient supply; and till the budding leaves are furnished, in sufficient abundance, for its support. When the leaves are put forth, the worms seem to feel the genial summons, and bursting from their little eggs, crawl upon the leaves, where they feed with a most voracious appetite. Thus they become larger by degrees; and after some months feeding, they lay, upon every leaf, small bundles, or cones of silk, which appear like so many golden apples, painted on a fine green ground. Such is the method of breeding them in the East; and without doubt it is best for the worms, and least troublesome for the feeder of them. But it is otherwise in our colder European climates; the frequent changes of the weather, and the heavy dews of our evenings render the keeping them all night exposed, subject to so many inconveniences, as to admit
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of no remedy. It is true, that by the assistance of nets, they may be preserved from the insults of birds; but the severe cold weather, which often succeeds the first heats of summer, as well as the rain and high winds, will destroy them all: and therefore, to breed them in Europe, they must be sheltered and protected from every external injury.

For this purpose, a room is chosen, with a south aspect; and the windows are so well glazed, as not to admit the least air: the walls are well built, and the planks of the floor exceeding close, so as to admit neither birds nor mice, nor even so much as an insect. In the middle there should be four pillars erected, or four wooden posts, so placed as to form a pretty large square. Between these are different stories made with ozier hurdles; and under each hurdle there should be a floor, with an upright border all round. These hurdles and floors must hang upon pullies, so as to be placed, or taken down at pleasure.

When the worms are hatched, some tender mulberry leaves are provided, and placed in the cloth or paper box in which the eggs were laid, and which are large enough to hold a great number. When they have acquired some strength, they must be distributed

buted on beds of mulberry leaves, in the different stories of the square in the middle of the room, round which a person may freely pass on every side. They will fix themselves to the leaves, and afterwards to the sticks of the hurdles, when the leaves are devoured. They have then a thread, by which they can suspend themselves on occasion, to prevent any shock by a fall; but this is by no means to be considered as the silk which they spin afterwards in such abundance. Care must be taken that fresh leaves be brought every morning, which must be strewed very gently and equally over them; upon which the silk-worms will forsake the remainder of the old leaves, which must be carefully taken away, and every thing kept very clean; for nothing hurts these insects so much as moisture and uncleanness. For this reason their leaves must be gathered when the weather is dry, and kept in a dry place, if it be necessary to lay in a store. As these animals have but a short time to live, they make use of every moment, and almost continually are spinning, except at those intervals when they change their skins. If mulberry leaves be difficult to be obtained, the leaves of lettuce or holyoak will sustain them: but they do not thrive so well upon their new diet; and their silk will neither be so copious, nor of so good a quality.

Though

Though the judicious choice, and careful management of their diet, is absolutely necessary, yet there is another precaution of equal importance, which is to give them air, and open their chamber windows, at such times as the sun shines warmest. The place also must be kept as clean as possible; not only the several floors that are laid to receive their ordure, but the whole apartments in general. These things well observed, contribute greatly to their health and encrease.

The worm, at the time it bursts the shell, is extremely small, and of a black colour; but the head is of a more shining black than the rest of the body: some days after, they begin to turn whitish, or of an ash-coloured grey. After the skin begins to grow too rigid, or the animal is stunted within it, the insect throws it off, and appears clothed a-new: it then becomes larger and much whiter, though it has a greenish cast: after some days, which are more or less, according to the different heat of the climate, or to the quality of the food, it leaves off eating, and seems to sleep for two days together: then it begins to stir, and put itself into violent motions, till the skin falls off the second time, and is thrown aside by the animal's feet. All these changes are made in
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three weeks or a month's time ; after which it begins to feed once more, still in its caterpillar form, but a good deal differing from itself before its change. In a few days time it seems to sleep again ; and, when it awakes, it again changes its cloathing, and continues feeding as before. When it has thus taken a sufficiency of food, and its parts are disposed for assuming the aurelia form, the animal forfakes, for the last time, all food and society, and prepares itself a retreat to defend it from external injuries, while it is seemingly deprived of life and motion.

This retreat is no other than its cone, or ball of silk, which Nature has taught it to compose with great art ; and within which it buries itself, till it assumes its winged form. This cone or ball is spun from two little longish kinds of bags that lie above the intestines, and are filled with a gummy fluid, of a marigold colour. This is the substance of which the threads are formed ; and the little animal is furnished with a surprizing apparatus for spinning it to the degree of fineness which its occasions may require. This instrument in some measure resembles a wire-drawer's machine, in which gold or silver threads are drawn to any degree of minuteness ; and through this the animal draws its thread with great assiduity. As every thread proceeds
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from two gum bags, it is probable that each supplies its own; which, however, are united, as they proceed from the animal's body. If we examine the thread with a microscope, it will be found that it is flattened on one side, and grooved along its length: from hence we may infer, that it is doubled just upon leaving the body; and that the two threads stick to each other by that gummy quality of which they are possessed. Previous to spinning its web, the silk worm seeks out some convenient place to erect its cell, without any obstruction. When it has found a leaf, or a chink fitted to its purpose, it begins to wreath its head in every direction, and fastens its thread on every side to the sides of its retreat. Though all its first essays seem perfectly confused, yet they are not altogether without design: there appears indeed, no order or contrivance in the disposal of its first threads; they are by no means laid artfully over each other, but are thrown out at random, to serve as an external shelter against rain; for nature having appointed the animal to work upon trees in the open air, its habits remain, though it is brought up in a warm apartment.

Malpighi pretends to have observed six different layers in a single cone of silk: but what may easily be observed is, that it
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is composed externally of a kind of rough cotton-like substance, which is called floss; within the thread is more distinct and even; and next the body of the aurelia, the apartment seems lined with a substance of the hardness of paper, but of a much stronger consistence. It must not be supposed, that the thread which goes to compose the cone, is rolled round, as we roll a bottom; on the contrary, it lies upon it in a very irregular manner, and winds off now from one side of the cone, and then from the other. This whole thread, if measured, will be found about three hundred yards long; and so very fine, that eight or ten of them are generally rolled off into one by the manufacturers. The cone, when completed, is in form like a pigeon's egg, and more pointed at one end than the other; at the smaller end, the head of the aurelia is generally found; and this is the place that the insect, when converted into a moth, is generally seen to burst through.

It is generally a fortnight or three weeks before the aurelia is changed into a moth; but no sooner is the winged insect completely formed, than having divested itself of its aurelia skin, it prepares to burst through its cone, or outward prison: for this purpose it extends its
head

head towards the point of the cone, butts with its eyes, which are rough, against the lining of its cell, wears it away, and at last pushes forward, through a passage which is small at first, but which enlarges as the animal encreases its efforts for emancipation; while the tattered remnants of its aurelia skin lie in confusion within the cone, like a bundle of dirty linen.

The animal, when thus set free from its double confinement, appears exhausted with fatigue, and seems produced for no other purpose but to transmit a future brood. It neither flies nor eats; the male only seeking the female, whose eggs he impregnates; and their union continues for four days, without interruption. The male dies immediately after separation from his mate; and she survives him only till she has laid her eggs, which are not hatched into worms till the ensuing spring.

However, there are few of these animals suffered to come to a state of maturity; for as their bursting through the cone destroys the silk, the manufacturers take care to kill the aurelia, by exposing it to the sun, before the moth comes to perfection. This done, they take off the floss, and throw the cones into warm water, stirring them till the first thread offers them a clue for winding all off. They generally take eight of the filken threads

threads together ; the cones still kept under water, till a proper quantity of the silk is wound off : however, they do not take all ; for the latter parts grow weak, and are of a bad colour. As to the paper-like substance which remains, some stain it with a variety of colours, to make artificial flowers ; others let it lie in the water, till the glutinous matter which cements it is all dissolved : it is then carded like wool, spun with a wheel, and converted into silk stuffs of an inferior kind.



PART IV.

THE HISTORY OF THE
CITY OF BOSTON
FROM THE FIRST SETTLEMENT
TO THE PRESENT TIME
IN TWO VOLUMES
BY NATHANIEL BENTLEY
OF THE BOSTON BAR
VOL. II
PUBLISHED BY J. B. BENTLEY
1822

P A R T IV

C H A P. I.

Of the Fourth Order of Insects.

IN the foregoing part we treated of caterpillars changing into butterflies ; in the present will be given the history of grubs changing into their corresponding winged animals. These, like the former, undergo their transformation, and appear as grubs or maggots, as aurelias, and at last as winged insects. Like the former, they are bred from eggs ; they feed in their reptile state ; they continue motionless and lifeless, as aurelias ; and fly and propagate, when furnished with wings. But they differ in many respects : the grub or maggot wants the number of feet which the caterpillar is seen to have ; the aurelia is not so totally wrapped up, but that its feet and its wings appear. The perfect animal, when emancipated, also has its wings either cased, or transparent, like gauze ; not coloured with that beautifully painted dust which adorns the wings of the butterfly.

In this class of insects, therefore, we may place a various tribe, that are first laid as eggs, then are excluded as maggots or grubs, then change into aurelias, with their legs and wings not wrapped up, but appearing;
and

and lastly, assuming wings, in which state they propagate their kind. Some of these have four transparent wings, as bees; some have two membranous cases to their wings, as beetles; and some have but two wings, which are transparent, as ants. Here, therefore, we will place the bee, the wasp, the humble bee, the ichneumon fly, the gnat, the tipula or longlegs, the beetle, the may-bug, the glow-worm, and the ant. The transformations which all these undergo, are pretty nearly similar; and though very different animals in form, are yet produced nearly in the same manner.



C H A P. II.

Of the Bce.

TO give a complete history of this insect in a few pages, which some have exhausted volumes in describing, and whose nature and properties still continue in dispute, is impossible. It will be sufficient to give a general idea of the animal's operations; which, though they have been studied for more than two thousand years, are still but incompletely known. The account given us by Reaumur is sufficiently minute; and, if true, sufficiently wonderful: but I find many of the facts which he relates, doubted by those who are most conversant with bees; and some of them actually declared not to have a real existence in nature.

It is unhappy, therefore, for those whose method demands an history of bees, that they are unfurnished with those materials which have induced so many observers to contradict so great a naturalist. His life was spent in the contemplation; and it requires an equal share of attention, to prove the error of his discoveries. Without entering, therefore, into the dispute, I will take him for my guide; and just mention, as I go

along, those particulars in which succeeding observers have begun to think him erroneous. Which of the two are right, time only can discover ; for my part I have only heard one side, for as yet none have been so bold as openly to oppose Reaumur's delightful researches.

There are three different kinds of bees in every hive. First, the labouring bees, which make up the far greatest number, and are thought to be neither male or female, but merely born for the purposes of labour, and continuing the breed, by supplying the young with provision, while yet in their helpless state. The second sort are the drones ; they are of a darker colour, longer, and more thick by one third than the former: they are supposed to be the males ; and there is not above a hundred of them, in a hive of seven or eight thousand bees. The third sort is much larger than either of the former, and still fewer in number : some assert, that there is not above one in every swarm ; but this later observers affirm not to be true, there being sometimes five or six in the same hive. These are called queen bees, and are said to lay all the eggs from which the whole swarm is hatched in a season.

In examining the structure of the common working bee, the first remarkable part that offers

offers is the trunk, which serves to extract the honey from flowers. It is not formed, like that of other flies, in the manner of a tube, by which the fluid is to be sucked up ; but like a besom, to sweep, or a tongue, to lick it away. The animal is furnished also with teeth, which serve it in making wax. This substance is gathered from flowers, like honey ; it consists of that dust or farina which contributes to the fecundation of plants, and is molded into wax by the little animal, at leisure. Every bee, when it leaves the hive to collect this precious store, enters into the cup of the flower, particularly such as seem charged with the greatest quantities of this yellow farina. As the animal's body is covered over with hair, it rolls itself within the flower, and soon becomes quite covered with the dust, which it soon after brushes off with its two hind legs, and kneads into two little balls. In the thighs of the hind legs there are two cavities, edged with hair ; and into these, as into a basket, the animal sticks its pellets. Thus employed, the bee flies from flower to flower, encreasing its store, and adding to its stock of wax ; until the ball, upon each thigh, becomes as big as a grain of pepper : by this time, having got a sufficient load, it returns, making the best of its way to the hive.

The belly of the bee is divided into six rings, which sometime shorten the body, by flipping one over the other. It contains within it, beside the intestines, the honey-bag, the venom-bag, and the sting. The honey-bag is as transparent as chrystal, containing the honey that the bee has brushed from the flowers; of which the greater part is carried to the hive, and poured into the cells of the honey-comb; while the remainder serves for the bee's own nourishment: for, during summer, it never touches what has been laid up for the winter. The sting, which serves to defend this little animal from its enemies, is composed of three parts; the sheath, and two darts, which are extremely small and penetrating. Both the darts have several small points or barbs, like those of a fish-hook, which renders the sting more painful, and makes the darts rankle in the wound. Still, however, this instrument would be very slight, did not the bee poison the wound. The sheath, which has a sharp point, makes the first impression; which is followed by that of the darts, and then the venomous liquor is poured in. The sheath sometimes sticks so fast in the wound, that the animal is obliged to leave it behind; by which the bee soon after dies, and the wound is considerably enflamed. It might at first
appear

appear well for mankind, if the bee were without its sting; but, upon recollection, it will be found, that the little animal would then have too many rivals in sharing its labours. An hundred other lazy animals, fond of honey, and hating labour, would intrude upon the sweets of the hive; and the treasure would be carried off, for want of armed guardians to protect it.

From examining the bee singly, we now come to consider it in society, as an animal not only subject to laws, but active, vigilant, laborious, and disinterested. All its provisions are laid up for the community; and all its arts in building a cell, designed for the benefit of posterity. The substance with which bees build their cells is wax; which is fashioned into convenient apartments for themselves and their young. When they begin to work in their hives, they divide themselves into four companies: one of which roves in the fields in search of materials; another employs itself in laying out the bottom and partitions of their cells; a third is employed in making the inside smooth from the corners and angles; and the fourth company bring food for the rest, or relieve those who return with their respective burthens. But they are not kept constant to one employment; they often change the tasks assigned them: those that have been

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at work, being permitted to go abroad; and those that have been in the fields already, take their places. They seem even to have signs, by which they understand each other; for when any of them want food, it bends down its trunk to the bee from whom it is expected, which then opens its honey-bag, and lets some drops fall into the other's mouth, which is at that time opened to receive it. Their diligence and labour is so great, that, in a day's time, they are able to make cells, which lie upon each other numerous enough to contain three thousand bees.

If we examine their cells, they will be found formed in the exactest proportion. It was said by Pappus, an ancient geometrician, that, of all other figures, hexagons were the most convenient; for, when placed touching each other, the most convenient room would be given, and the smallest lost. The cells of the bees are perfect hexagons: these, in every honeycomb, are double, opening on either side, and closed at the bottom. The bottoms are composed of little triangular panes, which, when united together, terminate in a point, and lie exactly upon the extremities of other panes of the same shape, in opposite cells. These lodgings have spaces, like streets, between them, large enough to give the bees

bees a free passage in and out ; and yet narrow enough to preserve the necessary heat. The mouth of every cell is defended by a border, which makes the door a little less than the inside of the cell, which serves to strengthen the whole. These cells serve for different purposes : for laying up their young ; for their wax, which in winter becomes a part of their food ; and for their honey, which makes their principal subsistence.

It is well known that the habitation of bees ought to be very close ; and what their hives want, from the negligence and unskilfulness of man, these animals supply by their own industry : so that it is their principal care, when first hived, to stop up all the crannies. For this purpose they make use of a resinous gum, which is more tenacious than wax, and differs greatly from it. This the ancients called Propolis : it will grow considerably hard in June ; though it will in some measure soften by heat ; and is often found different in consistence, colour and smell. It has generally an agreeable aromatic odour when it is warmed ; and by some it is considered as a most grateful perfume. When the bees begin to work with it, it is soft, but it acquires a firmer consistence every day ; till at length it assumes a brown colour,

colour, and becomes much harder than wax. The bees carry it on their hinder legs; and some think it is met with on the birch, the willow, and poplar. However it is procured, it is certain that they plaister the inside of their hives with this composition.

If examined through a glass hive, from the hurry the whole swarm is in, the whole at first appears like anarchy and confusion: but the spectator soon finds every animal diligently employed, and following one pursuit, with a settled purpose. Their teeth are the instruments by which they model and fashion their various buildings, and give them such symmetry and perfection. They begin at the top of the hive; and several of them work at a time, at the cells which have two faces. If they are stinted with regard to time, they give the new cells but half the depth which they ought to have; leaving them imperfect, till they have sketched out the number of cells necessary for the present occasion. The construction of their combs, costs them a great deal of labour: they are made by insensible additions; and not cast at once in a mold, as some are apt to imagine. There seems no end of their shaping, finishing, and turning them neatly up. The cells for their young are most carefully formed; those designed for lodging the drones, are larger than the rest; and that
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for the queen-bee, the largest of all. The cells in which the young brood are lodged, serve at different times for containing honey; and this proceeds from an obvious cause: every worm, before it is transformed into an aurelia, hangs its old skin on the partitions of its cell; and thus, while it strengthens the wall, diminishes the capacity of its late apartment. The same cell, in a single summer, is often tenanted by three or four worms in succession; and the next season, by three or four more. Each worm takes particular care to fortify the pannels of its cell, by hanging up its spoils there: thus, the partitions being lined, six or eight deep, become at last too narrow for a new brood, and are converted into store-houses, for honey.

Those cells where nothing but honey is deposited, are much deeper than the rest. When the harvest of honey is so plentiful that they have not sufficient room for it, they either lengthen their combs, or build more; which are much longer than the former. Sometimes they work at three combs at a time; for, when there are three work-houses, more bees may be thus employed, without embarrassing each other.

But honey, as was before observed, is not the only food upon which these animals subsist.

subſiſt. The meal of flowers, of which their wax is formed, is one of their moſt favourite repaſts. This is a diet which they live upon during the ſummer ; and of which they lay up a large winter proviſion. The wax of which their combs are made, is no more than this meal digeſted, and wrought into a paſte. When the flowers upon which bees generally feed, are not fully blown, and this meal or duſt is not offered in ſufficient quantities, the bees pinch the tops of the ſtamina in which it is contained, with their teeth ; and thus anticipate the progrefs of vegetation. In April and May, the bees are buſy, from morning to evening, in gathering this meal ; but when the weather becomes too hot in the miſt of ſummer, they work only in the morning.

The bee is furniſhed with a ſtomach for its wax, as well as its honey. In the former of the two, their powder is altered, digeſted and concocted into real wax ; and is thus ejected by the ſame paſſage by which it was ſwallowed. Every comb, newly made, is white : but it becomes yellow as it grows old, and almoſt black when kept too long in the hive. Beſide the wax thus digeſted, there is a large portion of the powder kneaded up for food in every hive, and kept in ſeparate cells, for winter proviſion.

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This is called, by the country people, bee-bread ; and contributes to the health and strength of the animal during winter. Those who rear bees, may rob them of their honey, and feed them, during the winter, with treacle ; but no proper substitute has yet been found for the bee-bread ; and, without it, the animals become consumptive and die.

As for the honey, it is extracted from that part of the flower called the nectareum. From the mouth this delicious fluid passes into the gullet : and then into the first stomach, or honey-bag, which, when filled, appears like an oblong bladder. Children, that live in country places, are well acquainted with this bladder ; and destroy many bees to come at their store of honey. When a bee has sufficiently filled its first stomach, it returns back to the hive, where it disgorges the honey into one of the cells. It often happens that the bee delivers its store to some other, at the mouth of the hive, and flies off for a fresh supply. Some honey-combs are always left open for common use ; but many others are stopped up, till there is a necessity of opening them. Each of these are covered carefully with wax ; so close, that the covers seem to be made at the very instant the fluid is deposited within them.

Having

Having thus given a cursory description of the insect, individually considered, and of the habitation it forms, we next come to its social habits and institutions : and, in considering this little animal attentively, after the necessary precautions for the immediate preservation of the community, its second care is turned to the continuance of posterity. How numerous soever the multitude of bees may appear in one swarm, yet they all owe their original to a single parent, which is called the queen-bee. It is indeed surprizing that a single insect shall, in one summer, give birth to above twenty thousand young : but, upon opening her body, the wonder will cease ; as the number of eggs appearing, at one time, amounts to five thousand. This animal, whose existence is of such importance to her subjects, may easily be distinguished from the rest, by her size, and the shape of her body. On her safety depends the whole welfare of the commonwealth ; and the attentions paid her by all the rest of the swarm, evidently shew the dependence her subjects have upon her security. If this insect be carefully observed, she will be seen at times attended with a numerous retinue, marching from cell to cell, plunging the extremity of her body into many of them, and leaving a small egg in each.

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The bees which generally compose her train, are thought to be males, which serve to impregnate her by turns. These are larger and blacker than the common bees ; without stings, and without industry. They seem formed only to transmit a posterity ; and to attend the queen, whenever she thinks proper to issue from the secret retreats of the hive, where she most usually resides. Upon the union of these two kinds depends all expectations of a future progeny ; for the working bees are of no sex, and only labour for another offspring : yet such is their attention to their queen, that if she happens to die, they will leave off working, and take no farther care of posterity. If, however, another queen is in this state of universal despair presented them, they immediately acknowledge her for sovereign, and once more diligently apply to their labour. It must be observed, however, that all this fertility of the queen-bee, and the great attentions paid to her by the rest, are controverted by more recent observers. They assert, that the common bees are parents themselves ; that they deposite their eggs in the cells which they have prepared ; that the females are impregnated by the males, and bring forth a progeny, which is wholly their own.

However,

However, to go on with their history, as delivered us by Mr. Reamur—When the queen-bee has deposited the number of eggs necessary in the cells, the working bees undertake the care of the rising posterity. They are seen to leave off their usual employments ; to construct proper receptacles for eggs ; or to complete those that are already formed. They purposely build little cells, extremely solid, for the young ; in which they employ a great deal of wax : those designed for lodging the males, as was already observed, are larger than the rest ; and those for the queen-bees the largest of all. There is usually but one egg deposited in every cell ; but when the fecundity of the queen is such, that it exceeds the number of cells already prepared, there are sometimes three or four eggs crowded together in the same apartment. But this is an inconvenience that the working bees will by no means suffer. They seem sensible that, two young ones, stuffed up in the same cell, when they grow larger, will but embarrass, and at last destroy each other : they therefore take care to leave a cell to every egg ; and remove or destroy the rest.

The single egg that is left remaining, is fixed to the bottom of the cell, and touches it but in a single point. A day or two after it is deposited, the worm is excluded from the shell of
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the egg, having the appearance of a maggot rolled up in a ring, and lying softly on a bed of a whitish coloured jelly; upon which also the little animal begins to feed. In the mean time, the instant it appears, the working bees attend it with the most anxious and parental tenderness; they furnish it every hour with a supply of this whitish substance, on which it feeds and lies; and watch the cell with unremitting care. They are nurses that have a greater affection for the offspring of others, than many parents have for their own children. They are constant in visiting each cell, and seeing that nothing is wanting; preparing the white mixture, which is nothing but a composition of honey and wax, in their own bowels, with which they feed them. Thus attended, and plentifully fed, the worm, in less than six days time, comes to its full growth, and no longer accepts the food offered it. When the bees perceive that it has no further occasion for feeding, they perform the last offices of tenderness, and shut the little animal up in its cell; walling up the mouth of its apartment with wax: there they leave the worm to itself; having secured it from every external injury.

The worm is no sooner left enclosed, but, from a state of inaction, it begins to labour, extending

extending and shortening its body ; and by this means lining the walls of its apartment with a filken tapestry, which it spins in the manner of caterpillars, before they undergo their last transformation. When their cell is thus prepared, the animal is soon after transformed into an aurelia ; but differing from that of the common caterpillar, as it exhibits not only the legs, but the wings of the future bee, in its present state of inactivity. Thus, in about twenty, or one and twenty days after the egg was laid, the bee is completely formed, and fitted to undergo the fatigues of its state. When all its parts have acquired their proper strength and consistence, the young animal opens its prison, by piercing with its teeth the waxen door that confines it. When just freed from its cell, it is as yet moist, and incommoded with the spoils of its former situation ; but the officious bees are soon seen to flock round it, and to lick it clean on all sides with their trunks ; while another band, with equal assiduity, are observed to feed it with honey : others again begin immediately to cleanse the cell that has been just left ; to carry the ordures out of the hive, and to fit the place for a new inhabitant. The young bee soon repays their care, by its industry ; for as soon as ever its external parts become dry, it discovers its natural appetites for
for

for labour, and industriously begins the task, which it pursues unremittingly through life. The toil of man is irksome to him, and he earns his subsistence with pain; but this little animal seems happy in its pursuits, and finds delight in all its employments.

When just freed from the cell, and properly equipped by its fellow bees for duty, it at once issues from the hive, and instructed only by nature, goes in quest of flowers, chuses only those that yield it a supply, rejects such as are barren of honey, or have been already drained by other adventurers; and when loaded, is never at a loss to find its way back to the common habitation. After this first sally, it begins to gather the mealy powder, that lies on every flower, which is afterwards converted into wax; and with this, the very first day it returns with two large balls stuck to its thighs.

When bees first begin to break their prisons, there are generally above a hundred excluded in one day. Thus, in the space of a few weeks, the number of the inhabitants in one hive, of moderate size, becomes so great, that there is no place to contain the new comers; and they are scarcely excluded from the cell, when they are obliged, by the old bees, to sally forth in quest of new habitations. In other words, the hive

begins to swarm, and the new progeny prepares for exile.

While there is room enough in the hive, the bees remain quietly together; it is necessity alone that compels the separation. Sometimes, indeed, the young brood, with graceless obstinacy, refuse to depart, and even venture to resist their progenitors. The young ones are known by being browner than the old, with whiter hair; the old ones are of a lighter colour, with red hair. The two armies are therefore easily distinguishable, and dreadful battles are often seen to ensue. But the victory almost ever terminates with strict poetical justice in favour of the veterans, and the rebellious offspring are driven off, not without loss and mutilation.

In different countries, the swarms make their appearance at different times of the year, and there are several signs previous to this intended migration. The night before, an unusual buzzing is heard in the hive; in the morning, though the weather be soft and inviting, they seem not to obey the call, being intent on more important meditations within. All labour is discontinued in the hive, every bee is either employed in forcing, or reluctantly yielding a submission; at length, after some noise and tumult, a queen bee is chosen,

chosen, to guard, rather than conduct, the young colony to other habitations, and then they are marshalled without any apparent conductor. In less than a minute, they leave their native abode, and forming a cloud round their protectress, they set off, without seeming to know the place of their destination; *The world before them, where to chuse their place of rest.* The usual time of swarming, is from ten in the morning, to three in the afternoon, when the sun shines bright, and invites them to seek their fortunes. They flutter for a while, in the air, like flakes of snow, and sometimes undertake a distant journey, but more frequently are contented with some neighbouring asylum; the branch of a tree, a chimney top, or some other exposed situation. It is, indeed, remarkable, that all those animals, of whatever kind, that have long been under the protection of man, seem to lose a part of their natural sagacity, in providing for themselves. The rabbit, when domesticated, forgets to dig holes, the hen to build a nest, and the bee to seek a shelter, that shall protect it from the inclemencies of winter. In those countries, where the bees are wild, and unprotected by man, they are always sure to build their waxen cells in the hollow of a tree; but with us, they seem improvident in their choice, and the

first green branch that stops their flight, seems to be thought sufficient for their abode through winter. However, it does not appear, that the queen chuses the place where they are to alight, for many of the stragglers, who seem to be pleased with a particular branch, go and settle upon it; others are seen to succeed, and at last, the queen herself, when she finds a sufficient number there before her, goes to make it the place of her head quarters. When the queen is settled, the rest of the swarm soon follow; and, in about a quarter of an hour, the whole body seem to be at ease. It sometimes is found, that there are two or three queens to a swarm, and the colony is divided into parties; but it most usually happens, that one of these is more considerable than the other, and the bees by degrees, desert the weakest, to take shelter under the most powerful protector. The deserted queen does not long survive this defeat; she takes refuge under the new monarch, and is soon destroyed by her jealous rival. Till this cruel execution is performed, the bees never go out to work; and if there should be a queen bee, belonging to the new colony, left in the old hive, she always undergoes the fate of the former. However, it must be observed, that the bees never sacrifice

crifice any of their queens, when the hive is full of wax and honey; for there is at that time, no danger in maintaining a plurality of breeders.

When the swarm is thus conducted to a place of rest, and the policy of government is settled, the bees soon resume their former labours. The making cells, storing them with honey, impregnating the queen, making proper cells for the reception of the rising progeny, and protecting them from external danger, employ their unceasing industry. But soon after, and towards the latter end of summer, when the colony is sufficiently stored with inhabitants, a most cruel policy ensues. The drone bees, which are (as has been said) generally in a hive, to the number of an hundred, are marked for slaughter. These, which had hitherto led a life of indolence and pleasure, whose only employment was in impregnating the queen, and rioting upon the labours of the hive, without aiding in the general toil, now share the fate of most voluptuaries, and fall a sacrifice to the general resentment of society.

The working bees, in a body, declare war against them; and in two or three days time, the ground all round the hive is covered with their dead bodies. Nay, the working bees will even kill such drones, as
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are yet in the worm state, in the cell, and eject their bodies from the hive, among the general carnage.

When a hive sends out several swarms in the year, the first is always the best, and the most numerous. These, having the whole summer before them, have the more time for making wax and honey, and consequently their labours are the most valuable to the proprietor. Although the swarm chiefly consists of the youngest bees, yet it is often found, that bees of all ages compose the multitude of emigrants, and it often happens, that bees of all ages are seen remaining behind. The number of them is always more considerable than that of some populous cities, for sometimes upwards of forty thousand are found in a single hive. So large a body may well be supposed to work with great expedition; and in fact, in less than twenty-four hours, they will make combs above twenty inches long, and seven or eight broad. Sometimes they will half fill their hives with wax, in less than five days. In the first fifteen days, they are always found to make more wax than they do afterwards during the rest of the year.

Such are the out-lines of the natural history of these animals, as usually found in our own country.

country. How they are treated, so as to produce the greatest quantity of honey, belongs rather to the rural œconomist, than the natural historian ; volumes have been written on the subject, and still more remains equally curious and new. One thing, however, it may be proper to observe, that a farm, or a country, may be over stocked with bees, as with any other sort of animal ; for a certain number of hives, always require a certain number of flowers to subsist on. When the flowers near home are rifled, then are these industrious insects seen taking more extensive ranges, but their abilities may be over taxed ; and if they are obliged, in quest of honey, to go too far from home, they are over-wearied in the pursuit, they are devoured by birds, or beat down by the winds and rain.

For a knowledge of this, in some parts of France and Piedmont, they have contrived, as I have often seen, a kind of floating bee-house.

They have on board one barge, threescore or an hundred bee-hives, well defended from the inclemency of an accidental storm ; and with these, the owners suffer themselves to float gently down the river. As the bees are continually chusing their flowery pastures along the banks of the stream, they are furnished with sweets before unrifled ; and thus a single float-
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ing bee-house, yields the proprietor a considerable income. Why a method similar to this has never been adopted in England, where we have more gentle rivers, and more flowery banks, than in any other part of the world, I know not; certainly it might be turned to advantage, and yield the possessor a secure, though perhaps a moderate income.

Having mentioned the industry of these admirable insects, it will be proper to say something of the effects of their labour, of that wax and honey, which are turned by man to such various uses. Bees gather together two kinds of wax, one coarse and the other fine. The coarser sort is bitter, and with this, which is called *propolis*, they stop up all the holes and crevices of their hives. It is of a more resinous nature than the fine wax, and is consequently better qualified to resist the moisture of the season, and preserve the works warm and dry within. The fine wax is as necessary to the animals preservation as the honey itself. With this they make their lodgings, with this they cover the cells of their young, and in this they lay up their magazines of honey. This is made, as has been already observed, from the dust of flowers, which is carefully kneaded by the little insect, then swallowed, and having undergone a kind of digestion, is formed
into

into the cells, which answers such a variety of purposes. To collect this, the animal rolls itself in the flower it would rob, and thus takes up the vegetable dust with the hair of its body. Then carefully brushing it into a lump, with its fore paws it thrusts the composition into two cavities behind the thighs, which are made like spoons to receive the wax, and the hair that lines them, serves to keep it from falling.

As of wax, there are also two kinds of honey. The white and the yellow. The white is taken without fire from the honey-combs. The yellow is extracted by heat, and squeezed through bags, in a press. The best honey is new, thick and granulated, of a clear transparent white colour, of a soft and aromatic smell, and of a sweet lively taste. Honey made in mountainous countries, is preferable to that of the valley. The honey made in the spring, is more highly esteemed, than that gathered in summer, which last is still more valuable, than that of autumn, when the flowers begin to fade and lose their fragrance.

The bees are nearly alike in all parts of the world, yet there are differences worthy our notice. In Guadaloupe, the bee is less by one half, than the European, and more black

black and round. They have no sting, and make their cells in hollow trees ; where, if the hole they meet with is too large, they form a sort of waxen house, of the shape of a pear, and in this they lodge and store their honey, and lay their eggs. They lay up their honey in waxen vessels, of the size of a pigeon's egg, of a black or deep violet colour ; and these are so joined together, that there is no space left between them. The honey never congeals, but is fluid, of the consistence of oil, and the colour of amber. Resembling these, there are found little black bees, without a sting, in all the tropical climates ; and though these countries are replete with bees, like our own, yet those form the most useful and laborious tribe in that part of the world. The honey they produce, is neither so unpalable, nor so surfeiting as ours ; and the wax is so soft, that it is only used for medicinal purposes, it being never found hard enough to form into candles, as in Europe.

Of insects, that receive the name of bees, among us, there are several ; which, however, differ very widely from that industrious social race we have been just describing. The HUMBLE BEE is the largest of all this tribe, being as large as the first joint of one's middle finger. These are seen in every field, and perched on
every

every flower. They build their nest in holes in the ground, of dry leaves, mixed with wax and wool, defended with moss from the weather. Each humble bee makes a separate cell about the size of a small nutmeg, which is round and hollow, containing the honey in a bag. Several of these cells are joined together, in such a manner, that the whole appears like a cluster of grapes. The females, which have the appearance of wasps, are very few, and their eggs are laid in cells, which the rest soon cover over with wax. It is uncertain whether they have a queen or not; but there is one much larger than the rest, without wings, and without hair, and all over black, like polished ebony. This goes and views all the works, from time to time, and enters into the cell, as if it wanted to see whether every thing was done right: In the morning, the young humble bees are very idle, and seem not at all inclined to labour, till one of the largest, about seven o'clock, thrusts half its body from a hole, designed for that purpose, and seated on the top of the nest, beats its wings for twenty minutes successively, buzzing the whole time, till the whole colony is put in motion. The humble bees gather honey, as well as the common

common bees ; but it is neither so fine, nor so good, nor the wax so clean, or so capable of fusion.

Besides the bees already mentioned, there are various kinds among us, that have much the appearance of honey-makers, and yet make only wax. The WOOD BEE is seen in every garden. It is rather larger than the common queen bee ; its body of a blueish black, which is smooth and shining. It begins to appear at the approach of spring, and is seen flying near walls exposed to a sunny aspect. This bee makes its nest in some piece of wood, which it contrives to scoop and hollow for its purpose. This, however, is never done in trees that are standing, for the wood it makes choice of is half rotten. The holes are not made directly forward, but turning to one side, and have an opening sufficient to admit one's middle finger ; from whence runs the inner apartment, generally twelve or fifteen inches long. The instruments used in boring these cavities, are their teeth ; the cavity is usually branched into three or four apartments ; and in each of these, they lay their eggs, to the number of ten or twelve, each separate and distinct from the rest : The egg is involved in a sort of paste, which serves at once for the young animal's protection and nourishment.

ment. The grown bees, however, feed upon small insects, particularly a louse, of a reddish brown colour, of the size of a small pin's head.

MASON BEES make their cells with a sort of mortar, made of earth, which they build against a wall that is exposed to the sun. The mortar, which at first is soft, soon becomes as hard as stone, and in this their eggs are laid. Each nest contains seven or eight cells, an egg in every cell, placed regularly one over the other. If the nest remains unhurt, or wants but little repairs, they make use of them the year ensuing: and thus they often serve three or four years successively. From the strength of their houses, one would think these bees in perfect security, yet none are more exposed than they. A worm with very strong teeth, is often found to bore into their little fortifications, and devour their young.

The GROUND BEE builds its nest in the earth, wherein they make round holes, five or six inches deep; the mouth being narrow, and only just sufficient to admit the little inhabitant. It is amusing enough, to observe the patience and assiduity with which they labour. They carry out all the earth, grain by grain, to the mouth of the hole, where it forms a little hillock, an Alps compared

compared to the power of the artist by which it is raised. Sometimes the walks of a garden are found undermined by their labours; some of the holes running directly downward, others horizontally beneath the surface. They lay up in these cavities provisions for their young, which consist of a paste that has the appearance of corn, and is of a sweetish taste.

The **LEAF-CUTTING BEES** make their nest and lay their eggs among bits of leaves, very artificially placed in holes in the earth, of about the length of a tooth-pick case. They make the bits of leaves of a roundish form, and with them line the inside of their habitations. This tapestry is still further lined by a reddish kind of paste, somewhat sweet or acid. These bees are of various kinds; those that build their nests with chefnut-leaves are as big as drones, but those of the rose-tree are smaller than the common bee.

The **WALL BEES** are so called, because they make their nests in walls of a kind of silky membrane with which they fill up the vacuities between the small stones which form the sides of their habitation. Their apartment consists of several cells placed end to end, each in the shape of a woman's thimble. Though the web which lines this
habitation

habitation is thick and warm, yet it is transparent and of a whitish colour. This substance is supposed to be spun from the animal's body; the male and females are of a size, but the former are without a sting. To these varieties of the bee kind might be added several others which are all different in nature, but not sufficiently distinguished to excite curiosity.



CHAP.

C H A P. III.

Of the Wasp and Hornet.

HOWEVER similar many insects may be in appearance, this does not imply a similitude in their history. The bee and the wasp resemble each other very strongly, yet, in examining their manner and their duration, they differ very widely; the bee labours to lay up honey, and lives to enjoy the fruits of its industry; the wasp appears equally assiduous, but only works for posterity, as the habitation is scarcely completed when the inhabitant dies.

The wasp is well known to be a winged insect with a sting. To be longer in proportion to its bulk than the bee, to be marked with bright yellow circles round its body, and to be the most swift and active insect of all the fly kind. On each side of the mouth this animal is furnished with a long tooth, notched like a saw, and with these it is enabled to cut any substance, not omitting meat itself, and to carry it to its nest. Wasps live like bees in community, and sometimes ten or twelve thousand are found inhabiting a single nest.

Of

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Of all other insects the wasp is the most fierce, voracious, and most dangerous, when enraged. They are seen wherever flesh is cutting up, gorging themselves with the spoil, and then flying to their nests with their reeking prey. They make war also on every other fly, and the spider himself dreads their approaches.

Every community among bees is composed of females or queens, drones or males, and neutral or working bees. Wasps have similar occupations; the two first are for propagating the species, the last for nursing, defending and supporting the rising progeny. Among bees, however, there is seldom above a queen or two in an hive; among wasps there are above two or three hundred.

As soon as the summer begins to invigorate the insect tribes, the wasps are the most of the number, and diligently employed either in providing provisions for their nest, if already made, or in making one, if the former habitation be too small to receive the encreasing community. The nest is one of the most curious objects in natural history, and contrived almost as artificially as that of the bees themselves. Their principal care is to seek out an hole that has been begun by some other animal, a field mouse,

a rat, or a mole, to build their nests in. They sometimes build upon the plain, where they are sure of the dryness of their situation, but most commonly on the side of a bank to avoid the rain or water that would otherwise annoy them. When they have chosen a proper place, they go to work with wonderful assiduity. Their first labour is to enlarge and widen the hole, taking away the earth and carrying it off to some distance. They are perfectly formed for labour, being furnished with a trunk above their mouths, two saws on each side which play to the right and left against each other, and six strong muscular legs to support them. They cut the earth into small parcels with their saws, and carry it out with their legs or paws. This is the work of some days; and at length the outline of their habitation is formed, making a cavity of about a foot and an half every way. While some are working in this manner, others are roving the fields to seek out materials for their building. To prevent the earth from falling down and crushing their rising city into ruin, they make a sort of roof with their gluey substance, to which they begin to fix the rudiment of their building, working from the top downwards, as if they were hanging a bell,

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bell, which, however at length they close up at the bottom. The materials with which they build their nests are bits of wood and glue. The wood they get where they can from the rails and posts which they meet with in the fields and elsewhere. These they saw and divide into a multitude of small fibres, of which they take up little bundles in their claws, letting fall upon them a few drops of gluey matter with which their bodies are provided, by the help of which they knead the whole composition into a paste, which serves them in their future building. When they have returned with this to the nest, they stick their load of paste on that part where they make their walls and partitions; they tread it close with their feet, and trowel it with their trunks, still going backwards as they work. Having repeated this operation three or four times, the composition is at length flatted out until it becomes a small leaf of a grey colour, much finer than paper, and of a pretty firm texture. This done the same wasp returns to the field to collect a second load of paste, repeating the same several times, placing layer upon layer, and strengthening every partition in proportion to the wants or conveniencies of the general fabric. Other working wasps come quickly after to repeat

the same operation, laying more leaves upon the former, till at length, after much toil, they have finished the large roof which is to secure them from the tumbling in of the earth. This dome being finished, they make another entrance to their habitation, designed either for letting in the warmth of the sun, or for escaping in case one door be invaded by plunderers. Certain however it is, that by one of these they always enter, by the other they sally forth to their toil; each hole being so small that they can pass but one at a time. The walls being thus composed, and the whole somewhat of the shape of a pear, they labour at their cells, which they compose of the same paper-like substance that goes to the formation of their outside works. Their combs differ from those of bees, not less in the composition than the position which they are always seen to obtain. The honeycomb of the bee is edgewise with respect to the hive; that of the wasp is flat, and the mouth of every cell opens downwards. Thus is their habitation, contrived story above story, supported by several rows of pillars which give firmness to the whole building, while the upper story is flat-roofed, and as smooth as the pavement of a room, laid with squares of marble. The wasps can freely walk upon these stories
between

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between the pillars to do whatever their wants require. The pillars are very hard and compact, being larger at each end than in the middle, not much unlike the columns of a building. All the cells of the nest are only destined for the reception of the young, being replete with neither wax nor honey.

Each cell is like that of the bee, hexagonal; but they are of two sorts, the one larger for the production of the male and female wasps, the other less for the reception of the working part of the community. When the females are impregnated by the males, they lay their eggs, one in each cell, and stick it in with a kind of gummy matter to prevent its falling out. From this egg proceeds the insect in its worm-state, of which the old ones are extremely careful, feeding it from time to time till it becomes large and entirely fills up its cell. But the wasp community differs from that of the bee in this; that among the latter the working bees take the parental duties upon them, whereas among the wasps the females alone are permitted to feed their young, and to nurse their rising progeny. For this purpose the female waits with great patience till the working wasps have brought in their provisions, which she takes from them, and cuts into pieces. She then

then goes with great compofure from cell to cell, and feeds every young one with her mouth. When the young worms have come to a certain fize they leave off eating, and begin to fpin a very fine filk, fixing the firft end to the entrance of the cell, then turning their heads, firft on one fide, then on the other, they fix the thread to different parts, and thus they make a fort of a door which ferves to clofe up the mouth of the cell. After this they divest themselves of their fkins after the ufual mode of transformation; the aurelia by degrees begins to emancipate itfelf from its fhell; by little and little it thrufts out its legs and wings, and infenfibly acquires the colour and fhape of its parent.

The wasp thus formed, and prepared for depredation, becomes a bold, troublefome, and dangerous infect: there are no dangers which it will not encounter in purfuit of its prey, and nothing feems to fatisfy its gluttony. Though it can gather no honey of its own, no animal is more fond of fweets. For this purpofe it will purfue the bee and the humble bee, deftroy them with its ftmg, and then plunder them of their honey-bag, with which it flies triumphantly loaded to its neft to regale its young. Wasps are ever fond of making their nefts in the neighbourhood of bees, merely to have

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have an opportunity of robbing their hives, and feasting on the spoil. Yet the bees are not found always patiently submissive to their tyranny, but fierce battles are sometimes seen to ensue, in which the bees make up by conduct and numbers what they want in personal prowess. When there is no honey to be had, they seek for the best and sweetest fruits, and they are never mistaken in their choice. From the garden they fly to the city, to the grocers shops, and butchers shambles. They will sometimes carry off bits of flesh half as big as themselves, with which they fly to their nests for the nourishment of their brood. Those who cannot drive them away, lay for them a piece of ox's liver, which being without fibres, they prefer to other flesh; and whenever they are found, all other flies are seen to desert the place immediately. Such is the dread with which these little animals impress all the rest of the insect tribes, which they seize and devour without mercy, that they vanish at their approach. Wherever they fly, like the eagle or the falcon, they form a desert in the air around them. In this manner the summer is passed in plundering the neighbourhood, and rearing up their young; every day adds to their numbers, and from their strength, agility, and indiscriminate appetite for every kind of provision,

provision, were they as long lived as the bee, they would soon swarm upon the face of nature, and become the most noxious plague of man : but providentially their lives are measured to their mischief, and they live but a single season.

While the summer heats continue, they are bold, voracious, and enterprizing ; but as the sun withdraws, it seems to rob them of their courage and activity. In proportion as the cold encreases, they are seen to become more domestic ; they seldom leave the nest, they make but short adventures from home, they flutter about in the noon-day heats, and soon after return chilled and feeble.

As their calamities encrease, new passions soon begin to take place ; the care for posterity no longer continues, and as the parents are no longer able to provide their growing progeny a supply, they take the barbarous resolution of sacrificing them all to the necessity of the times. In this manner, like a garrison upon short allowance, all the useless hands are destroyed ; the young worms, which a little before they fed and protected with so much assiduity, are now butchered and dragged from their cells. As the cold encreases they no longer find sufficient warmth in their nests, which grow hateful to them, and they fly to seek it in
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the corners of houses, and places that receive an artificial heat. But the winter is still insupportable; and, before the new year begins, they wither and die; the working bees first, the males soon following, and many of the females suffering in the general calamity. In every nest, however, one or two females survive the winter, and having been impregnated by the male during the preceding season, she begins in spring to lay her eggs in a little hole of her own contrivance. This bundle of eggs, which is clustered together like grapes, soon produces two worms which the female takes proper precaution to defend and supply, and these when hatched, soon give assistance to the female, who is employed in hatching two more; these also gathering strength, extricate themselves out of the web that enclosed them, and become likewise assistants to their mother; fifteen days after, two more make their appearance; thus is the community every day encreasing, while the female lays in every cell, first a male and then a female. These soon after become breeders in turn, till, from a single female, ten thousand wasps are seen produced before the month of June. After the female has thus produced her progeny, which are distributed in different districts, they assemble

semble from all parts, in the middle of summer, and provide for themselves the large and commodious habitation, which has been described above.

Such is the history of the social wasp ; but, as among bees, so also among these insects, there are various tribes that live in solitude : these lay their eggs in a hole for the purpose, and the parent dies long before the birth of its offspring. In the principal species of the SOLITARY WASPS, the insect is smaller than the working wasp of the social kind. The filament, by which the corselet is joined to the body, is longer and more distinctly seen, and the whole colour of the insect is blacker than in the ordinary kinds. But it is not their figure, but the manners of this extraordinary insect that claim our principal regard.

From the end of May to the beginning of July, this wasp is seen most diligently employed. The whole purpose of its life seems to be in contriving and fitting up a commodious apartment for its young one, which is not to succeed it till the year ensuing. For this end it is employed, with unwearied assiduity, in boring a hole into the finest earth some inches deep, but not much wider than the diameter of its own body. This is but a gallery leading to a wider apartment destined for the convenient lodgment of its young.

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young. As it always chuses a gravelly soil to work in, and where the earth is almost as hard as stone itself; the digging and hollowing this apartment is an enterprize of no small labour: for effecting its operations, this insect is furnished with two teeth, which are strong and firm, but not sufficiently hard to penetrate the substance through which it is resolved to make its way. In order therefore to soften that earth which it is unable to pierce, it is furnished with a gummy liquor which it emits upon the place, and which renders it more easily separable from the rest, and the whole becoming a kind of soft paste is removed to the mouth of the habitation. The animal's provision of liquor in these operations is however soon exhausted; and it is then seen either taking up water from some neighbouring flower or stream in order to supply the deficiency.

At length, after much toil, a hole some inches deep is formed, at the bottom of which is a large cavity; and to this no other hostile insect would venture to find its way, from the length and the narrowness of the defile through which it would be obliged to pass. In this the solitary wasp lays its egg, which is destined to continue the species; there the nascent animal is to continue

tinue for above nine months, unattended and immured, and at first appearance the most helpless insect of the creation. But when we come to examine, new wonders offer, no other insect can boast so copiously luxurious a provision, or such confirmed security.

As soon as the mother-wasp has deposited her egg at the bottom of the hole, her next care is to furnish it with a supply of provisions, which may be offered to the young insect as soon as it leaves the egg. To this end she procures a number of little green worms, generally from eight to twelve, and these are to serve as food for the young one the instant it awakens into life. When this supply is regularly arranged and laid in, the old one then, with as much assiduity as it before worked out its hole, now closes the mouth of the passage; and thus leaving its young one immured in perfect security, and in a copious supply of animal food, she dies satisfied with having provided for a future progeny.

When the young one leaves the egg it is scarcely visible, and is seen immured among a number of insects, infinitely larger than itself, ranged in proper order around it, which, however give it no manner of apprehension. Whether the parent, when she laid in the insect provision,

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provision, contrived to disable the worms from resistance, or whether they were at first incapable of any, is not known. Certain it is, that the young glutton feasts upon the living spoil without any controul; his game lies at his hand, and he devours one after the other as the calls of appetite incite him. The life of the young animal is therefore spent in the most luxurious manner, till its whole stock of worms is exhausted, and then the time of its transformation begins to approach; and then spinning a silken web, it continues fixed in its cell till the sun calls it from its dark abode the ensuing summer.

The wasps of Europe are very mischievous, yet they are innocence itself when compared to those of the tropical climates, where all the insect tribes are not only numerous, but large, voracious, and formidable. Those of the West Indies are thicker, and twice as long as the common bee; they are of a grey colour, striped with yellow, and armed with a very dangerous sting. They make their cells in the manner of a honey-comb, in which the young ones are hatched and bred. They generally hang their nests by threads, composed of the same substance with the cells, to the branches of trees, and the eaves of houses. They are seen every where in great abundance, descending like fruit, particularly

ticularly pears, of which shape they are, and as large as one's head. The inside is divided into three round stories, full of cells, each hexagonal, like those of an honey-comb. In some of the islands, these insects are so very numerous, that their nests are stuck up in this manner, scarce two feet asunder, and the inhabitants are in continual apprehension from their accidental resentment. It sometimes happens, that no precautions can prevent their attacks, and the pains of their sting is almost insupportable. Those who have felt it think it more terrible than even that of a scorpion; the whole visage swells, and the features are so disfigured, that a person is scarcely known by his most intimate acquaintance.



THE ICHNEUMON FLY. III

C H A P. IV.

Of the Ichneumon Fly.

EVERY rank of insects, how voracious soever, have enemies that are terrible to them, and that revenge upon them the injuries done upon the rest of the animated creation. The wasp, as we have seen, is very troublesome to man, and very formidable to the insect tribe ; but the ichneumon fly ; (of which there are many varieties) fears not the wasp itself, it enters its retreats, plunders its habitations, and takes possession of that cell for its own young, which the wasp had laboriously built for a dearer posterity.

Though there are many different kinds of this insect, yet the most formidable, and that best known, is called the common ichneumon, with four wings, like the bee, a long slender black body, and a three forked tail, consisting of bristles ; the two outermost black, and the middlemost red. This fly receives its name from the little quadrupede, which is found to be so destructive to the crocodile, as it bears a strong similitude in its courage and rapacity.

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Though this instrument is, to all appearance, slender and feeble, yet it is found to be a weapon of great force and efficacy. There is scarce any substance which it will not pierce ; and, indeed, it is seldom seen but employed in penetration. This is the weapon of defence, this is employed in destroying its prey, and still more, by this the animal deposits her eggs wherever she thinks fit to lay them. As it is an instrument chiefly employed for this purpose, the male is unprovided with such a sting, while the female uses it with great force and dexterity, brandishing it when caught, from side to side, and very often wounding those who thought they held her with the greatest security.

All the flies of this tribe are produced in the same manner, and owe their birth to the destruction of some other insect, within whose body they have been deposited, and upon whose vitals they have preyed, till they came to maturity. There is no insect whatever, which they will not attack, in order to leave their fatal present in its body ; the caterpillar, the gnat, and even the spider himself, so formidable to others, is often made the unwilling fosterer of this destructive progeny.

About the middle of summer, when other insects are found in great abundance, the ich-
neumon

neumon is seen flying busily about, and seeking proper objects upon whom to depose its progeny. As there are various kinds of this fly, so they seem to have various appetites. Some are found to place their eggs within the aurelia of some nascent insect, others place them within the nest, which the wasp had curiously contrived for its own young; and as both are produced at the same time, the young of the ichneumon, not only devours the young wasp, but the whole supply of worms, which the parent had carefully provided for its provision. But the greatest number of the ichneumon tribe are seen settling upon the back of the caterpillar, and darting, at different intervals, their stings into its body. At every dart they depose an egg, while the wounded animal seems scarcely sensible of the injury it sustains. In this manner they leave from six to a dozen of their eggs, within the fat substance of the reptile's body, and then fly off to commit further depredations. In the mean time the caterpillar thus irreparably injured, seems to feed as voraciously as before, does not abate of its usual activity; and to all appearance, seems no way affected by the internal enemies that are preparing its destruction in their darksome abode. But they soon burst from their egg state, and begin to prey upon the substance of their prison. As they grow

larger, they require a greater supply, till at last the animal, by whose vitals they are supported, is no longer able to sustain them, but dies; its whole inside being almost eaten away. It often happens, however, that it survives their worm state, and then they change into a chrysalis, enclosed in the caterpillar's body till the time of their delivery approaches, when they burst their prisons and fly away. The caterpillar, however, is irreparably destroyed, it never changes into a chrysalis, but dies shortly after, from the injuries it had sustained.

Such is the history of this fly, which though very terrible to the insect tribe, fails not to be of infinite service to mankind. The millions which it kills in a single summer, are unconceivable; and without such a destroyer, the fruits of the earth would only rise to furnish a banquet for the insect race, to the exclusion of all the nobler ranks of animated nature.



C H A P. V.

Of the Ant.

THOUGH the number of two-winged flies be very great, and the naturalists have taken some pains to describe their characters and varieties; yet there is such a similitude in their forms and manners, that in a work like this, one description must serve for all. We now therefore, come to a species of four-winged insects, that are famous from all antiquity, for their social and industrious habits, that are marked for their spirit of subordination, that are offered as a pattern of parsimony, to the profuse, and of unremitting diligence to the sluggard.

In the experiments, however, which have been more recently made, and the observations which have been taken, much of their boasted frugality and precaution seems denied them; the treasures they lay up, are no longer supposed, intended for future provision, and the choice they make in their stores, seems no way dictated by wisdom. It is, indeed, somewhat surprizing, that almost every writer of antiquity, should describe this insect, as labouring in the summer, and feasting upon the produce during the

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winter.

winter. Perhaps, in some of the warmer climates, where the winter is mild, and of short continuance, this may take place; but in France and England, these animals can have no manner of occasion for a supply of winter provisions, as they are actually in a state of torpidity during that season.

The common ants of Europe, are of two or three different kinds; some red, some black, some with stings, and others without. Such as have stings, inflict their wounds in that manner; such as are unprovided with these weapons of defence, have a power of spurt-ing, from their hinder parts, an acid pungent liquor, which, if it lights upon the skin, inflames and burns it like nettles.

The body of an ant is divided, into the head, breast and belly. In the head, the eyes are placed, which are entirely black, and under the eyes, there are two small horns or feelers, composed of twelve joints, all covered with a fine silky hair. The mouth is furnished with two crooked jaws, which project outwards, in each of which are seen incisures, that look like teeth. The breast is covered with a fine silky hair, from which project six legs, that are pretty strong and hairy, the extremities of each armed with two small claws, which the animal uses in climbing. The belly is more red-
dish

dish than the rest of the body, which is of a brown chesnut colour, it is as shining as glass, and covered with extremely fine hair.

From such a formation, this animal seems bolder, and more active, for its size, than any other of the insect tribe, and fears not to attack a creature, often above ten times its own magnitude.

As soon as the winter is past, in the first fine day in April, the ant hill, that before seemed a desert, now swarms with new life, and myriads of these insects are seen just awaked from their annual lethargy, and preparing for the pleasures and fatigues of the season. For the first day they never offer to leave the hill, which may be considered as their citadel, but run over every part of it, as if to examine its present situation, to observe what injuries it has sustained during the rigours of winter, * while they slept, and to meditate and settle the labours of the day ensuing.

At the first display of their forces, none but the wingless tribe appears, while those furnished with wings remain at the bottom. These are the working ants, that first appear, and that are always destitute of wings;
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* Memoires per servir a l'Histoire des insectes par Charles de Geer.

the males and females, that are furnished with four large wings each, are more flow in making their appearance.

Thus, like bees, they are divided into males, females, and the neutral or the working tribe. These are all easily distinguished from each other; the females are much larger than the males; the working ants are the smallest of all. The two former have wings; which, however, they sometimes are divested of; the latter never have any, and upon them are devolved all the labours that tend to the welfare of the community. The female, also, may be distinguished, by the colour and structure of her breast, which is a little more brown, than that of the common ant, and a little brighter than that of the male.

In eight or ten days after their first appearance, the labours of the hill are in some forwardness; the males and females are seen mixed with the working multitude, and pursued or pursuing each other. They seem no way to partake in the common drudgeries of the state; the males pursue the females with great assiduity, and in a manner, force them to compliance. They remain coupled for some time, while the males thus united, suffer themselves to be drawn along by the will of their partners.

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In the mean time, the working body of the state take no part in their pleasures, they are seen diligently going from the ant-hill, in pursuit of food for themselves and their associates, and of proper materials for giving a comfortable retreat to their young, or safety to their habitation. In the fields of England, ant-hills are formed with but little apparent regularity. In the more southern provinces of Europe, they are constructed with wonderful contrivance, and offer a sight highly worthy a naturalist's curiosity. These are generally formed in the neighbourhood of some large tree and a stream of water. The one is considered by the animals, as the proper place for getting food; the other for supplying them with moisture, which they cannot well dispense with. The shape of the ant-hill, is that of a sugar loaf, about three feet high, composed of various substances; leaves, bits of wood, sand, earth, bits of gum, and grains of corn. These are all united into a compact body, perforated with galleries down to the bottom, and winding ways within the body of the structure. From this retreat, to the water, as well as to the tree, in different directions, there are many paths worn by constant assiduity, and along these the busy insects are seen passing and repassing continually; so
that

that from May, or the beginning of June, according to the state of the season, they work continually, till the bad weather comes on.

The chief employment of the working ants, is in sustaining not only the idlers at home, but also finding a sufficiency of food for themselves. They live upon various provisions, as well of the vegetable as of the animal kind. Small insects they will kill and devour; sweets of all kinds, they are particularly fond of. They seldom, however, think of their community, till they themselves are first satiated. Having found a juicy fruit, they swallow what they can, and then tearing it in pieces, carry home their load. If they meet with an insect above their match, several of them will fall upon it at once, and having mangled it, each will carry off a part of the spoil. If they meet, in their excursions, any thing that is too heavy for one to bear, and yet, which they are unable to divide, several of them will endeavour to force it along; some dragging and others pushing. If any one of them happens to make a lucky discovery, it will immediately give advice to others, and then at once, the whole republic will put themselves in motion. If in these struggles, one of them happens to be killed,

killed, some kind survivor will carry him off to a great distance, to prevent the obstructions his body may give to the general spirit of industry.

But while they are thus employed in supporting the state, in feeding abroad, and carrying in provisions to those that continue at home, they are not unmindful of posterity. After a few days of fine weather, the female ants begin to lay their eggs, and those are as assiduously watched and protected by the working ants, who take upon themselves to supply whatever is wanting to the nascent animal's convenience or necessity. They are carried as soon as laid, to the safest situation, at the bottom of their hill, where they are carefully defended from cold and moisture. We are not to suppose, that those white substances which we so plentifully find in every ant-hill, are the eggs as newly laid. On the contrary, the ant's egg is so very small, that, though laid upon a black ground, it can scarcely be discerned. The little white bodies we see, are the young animals in their maggot state, endued with life, long since freed from the egg, and often involved in a cone, which it has spun round itself, like the silk worm. The real egg when laid, if viewed through a microscope, appears smooth, polished and shining, while the maggot

got is seen composed of twelve rings, and is often larger than the ant itself.

It is impossible to express the fond attachment which the working ants shew to their rising progeny. In cold weather they take them in their mouths, but without offering them the smallest injury, to the very depths of their habitation, where they are less subject to the severity of the season. In a fine day they remove them, with the same care, nearer the surface, where their maturity may be assisted by the warm beams of the sun. If a formidable enemy should come to batter down their whole habitation, and crush them by thousands in the ruin, yet these wonderful insects, still mindful of their parental duties, make it their first care to save their offspring. They are seen running wildly about and different ways, each loaded with a young one, often bigger than the insect that supports it. I have kept, says Swammerdam, several of the working ants in my closet, with their young, in a glass filled with earth, I took pleasure in observing, that in proportion as the earth dried on the surface, they dug deeper and deeper to deposite their eggs; and when I poured water thereon, it was surprising to see with what care, affection, and diligence they laboured, to put their brood in safety, in
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the driest place. I have seen also, that when water has been wanting for several days, and when the earth was moistened after it a little, they immediately carried their young ones to have a share, who seemed to enjoy and suck the moisture.

When the young maggot is come to its full growth, the breast swells insensibly, it casts its skin, and loses all motion. All the members which were hidden before, then begin to appear, an aurelia is formed, which represents very distinctly, all the parts of the animal, though they are yet without motion, and as it were, wrapped up in swaddling-cloaths. When at length, the little insect has passed through all its changes, and acquired its proper maturity, it bursts this last skin, to assume the form it is to retain ever after. Yet this is not done by the efforts of the little animal alone, for the old ones very assiduously break open, with their teeth, the covering in which it is enclosed. Without this assistance the aurelia would never be able to get free, as Mr. De Geer often found, who tried the experiment, by leaving the aurelia to themselves. The old ones not only assist them, but know the very precise time for lending their assistance, for if produced too soon the young one dies of cold,

cold, if retarded too long it is suffocated in its prison.

When the female has done laying, and the whole brood is thus produced, her labours, as well as that of the male, become unnecessary, and her wings, which she had but a short time before so actively employed, drop off. What becomes of her when thus divested of her ornaments is not well known, for she is seen in the cells for some weeks after. The males, on the other hand, having no longer any occupation at home, make use of those wings with which they have been furnished by nature, and fly away, never to return, or to be heard of more. It is probable they perish with the cold, or are devoured by the birds, which are particularly fond of this petty prey.

In the mean time, the working ants having probably deposed their queens, and being deserted by the males, that served but to clog the community, prepare for the severity of the winter, and bury their retreats as deep in the earth as they conveniently can. It is now found that the grains of corn, and other substances with which they furnish their hill, are only meant as fences to keep off the rigours of the weather, not as provisions to support them during its continuance. It is found generally to obtain, that
every

every insect that lives a year after it is come to its full growth, is obliged to pass four or five months without taking any nourishment, and will seem to be dead all that time. It would be to no purpose therefore for ants to lay up corn for the winter, since they lie that time without motion, heaped upon each other, and are so far from eating, that they are utterly unable to stir. Thus what authors have dignified by the name of a magazine, appears to be no more than a cavity, which serves for a common retreat when the weather forces them to return to their lethargic state.

What has been said with exaggeration of the European ant, is however true, if asserted of those of the tropical climates. They build an ant-hill with great contrivance and regularity, they lay up provisions, and, as they probably live the whole year, they submit themselves to regulations entirely unknown among the ants of Europe.

Those of Africa are of three kinds, the red, the green and the black ; the latter are above an inch long, and in every respect a most formidable insect. Their sting produces extreme pain, and their depredations are sometimes extremely destructive. They build an ant-hill of a very great size, from six to twelve feet high ; it is made of viscous clay,

clay, and tapers into a pyramidal form. This habitation is constructed with great artifice, and the cells are so numerous and even, that a honey-comb scarce exceeds them in number and regularity.

The inhabitants of this edifice seem to be under a very strict regulation. At the slightest warning they will fall out upon whatever disturbs them, and if they have time to arrest their enemies, he is sure to find no mercy. Sheep, hens, and even rats are often destroyed by these merciless insects, and their flesh devoured to the bone. No anatomist in the world can strip a skeleton so cleanly as they, and no animal, how strong soever, when they have once seized upon it, has power to resist them.

It often happens that these insects quit their retreat in a body, and go in quest of adventures. "During my stay," says Smith, "at Cape Corse Castle, a body of these ants came to pay us a visit in our fortification. It was about day-break when the advanced guard of this famished crew entered the chapel, where some negroe servants were asleep upon the floor. The men were quickly alarmed at the invasion of this unexpected army, and prepared, as well as they could, for a defence. While the foremost battalion of insects had already taken possession

“possession of the place, the rear-guard was
“more than a quarter of a mile distant.
“The whole ground seemed alive, and
“crawling with unceasing destruction. After
“deliberating a few moments upon what
“was to be done, it was resolved to lay a
“large train of gunpowder along the path
“they had taken, by this means millions
“were blown to pieces, and the rear guard
“perceiving the destruction of their leaders,
“thought proper instantly to return, and
“make back to their original habitation.”

The order which these ants observe, seems very extraordinary ; whenever they fall forth, fifty or sixty larger than the rest are seen to head the band, and conduct them to their destined prey. If they have a fixed spot where their prey continues to resort to, they then form a vaulted gallery, which is sometimes a quarter of a mile in length, and yet, they will hollow it out in the space of ten or twelve hours.

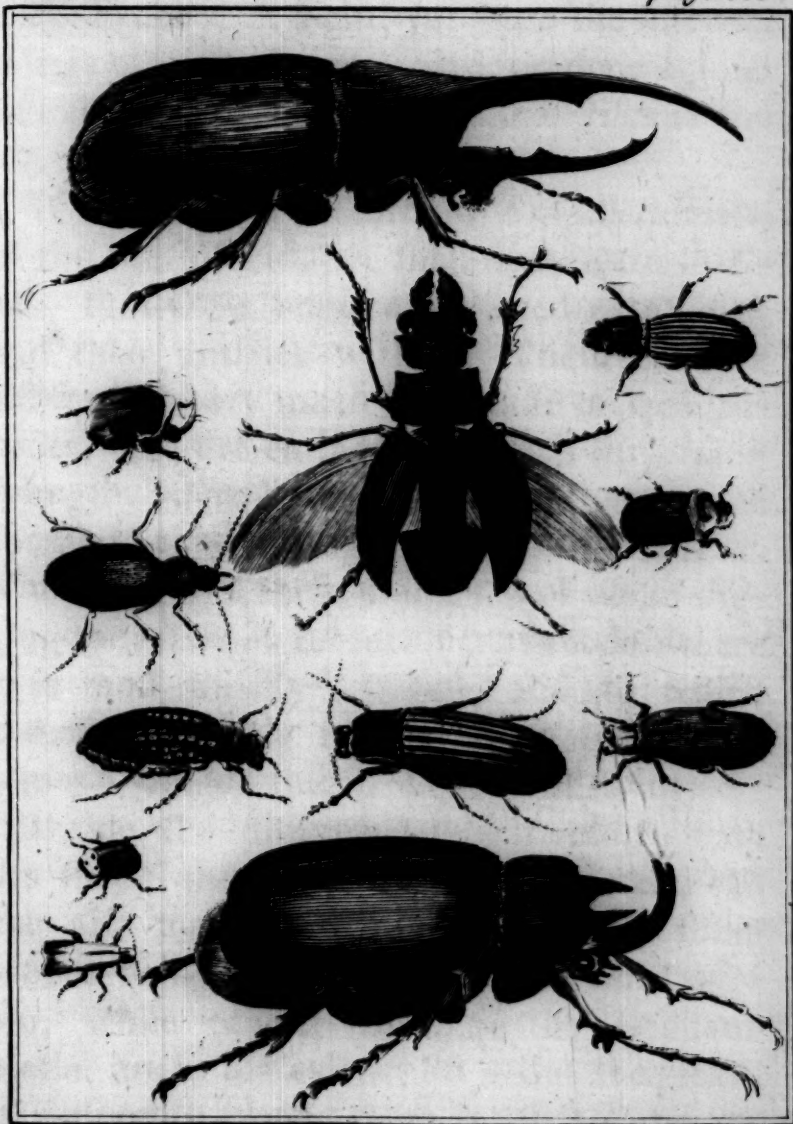


C H A P. VI.

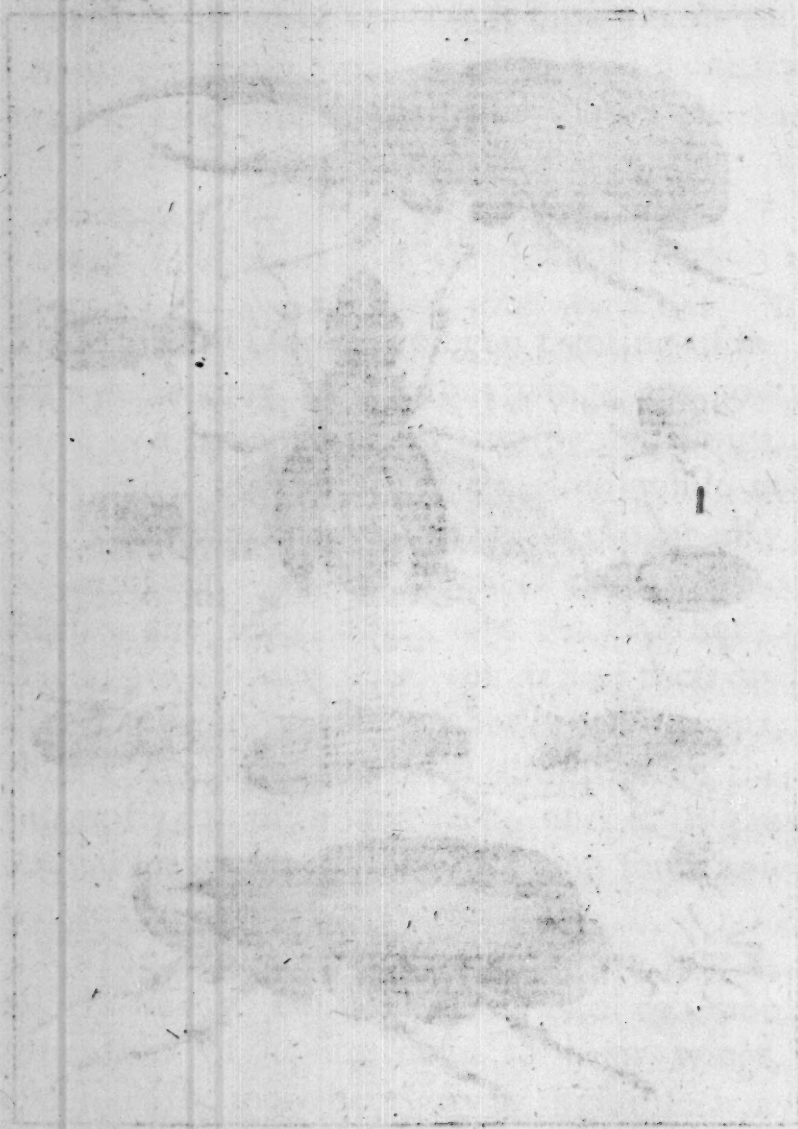
Of the Beetle and its Varieties.

HITHERTO we have been treating of insects with four transparent wings, we now come to a tribe with two transparent wings, with cases that cover them close while at rest, but which allow them their proper play when flying. The principal of these are the Beetle, the May Bug, and the Cantharis. These are all bred like the rest of their order, first from eggs, then they become grubs, then a chrysalis, in which the parts of the future fly are distinctly seen, and lastly the animal leaves its prison, breaking forth as a winged animal in full maturity.

Of the Beetle there are various kinds ; all, however, concurring in one common formation of having cases to their wings, which are the more necessary to those insects, as they often live under the surface of the earth, in holes, which they dig out by their own industry. These cases prevent the various injuries their real wings might sustain, by rubbing or crushing against the sides of their abode. These, though
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Beetles.



Heber

they do not assist flight, yet keep the internal wings clean and even, and produce a loud buzzing noise, when the animal rises in the air.

If we examine the formation of all animals, of the beetle kind, we shall find, as in shell-fish, that their bones are placed externally, and their muscles within. These muscles are formed very much like those of quadrupeds, and are endued with such surprizing strength, that bulk for bulk, they are a thousand times stronger than those of a man. The strength of these muscles is of use in digging the animal's subterraneous abode, where it is most usually hatched, and to which it most frequently returns, even after it becomes a winged insect, capable of flying.

Beside the difference which results from the shape and colour of these animals, the size also makes a considerable one; some beetles being not larger than the head of a pin, while others, such as the elephant beetle, are as big as ones fist: But the greatest difference among them is, that some are produced in a month, and in a single season go through all the stages of their existence, while others take near four years to their production; and live as winged insects a year more. To give the history of all these animals, that are bred pretty much in the

same way, would be insipid and endless ; it will suffice to select one or two from the number, the origin of which may serve as specimens of the rest. I will, therefore, offer the history of the may-bug to the reader's attention; premising, that most other beetles, though not so long lived, are bred in the same manner.

The may-bug, or dorr-beetle, as some call it, has, like all the rest, a pair of cases to its wings, which are of a reddish brown colour, sprinkled with a whitish dust, which easily comes off. In some years their necks are seen covered with a red plate, and in others, with a black; these, however, are distinct sorts, and their difference is by no means accidental. The fore legs are very short, and the better calculated for burrowing in the ground, where this insect makes its retreat. It is well known for its evening buzz to children; but still more formidably introduced to the acquaintance of husbandmen and gardeners, for in some seasons, it has been found to swarm in such numbers, as to eat up every vegetable production.

The two sexes in the may-bug, are easily distinguished from each other, by the superior length of the tufts, at the end of the horns,

horns, in the male. They begin to copulate in summer, and at that season, they are seen joined together for a considerable time. The female being impregnated, quickly falls to boring a hole into the ground, where to deposit her burthen. This is generally about half a foot deep, and in it she places her eggs, which are of an oblong shape, with great regularity, one by the other. They are of a bright yellow colour, and no way wrapped up in a common covering, as some have imagined. When the female is lightened of her burthen, she again ascends from her hole, to live as before, upon leaves and vegetables, to buzz in the summer evening, and to lie hid, among the branches of trees, in the heat of the day.

In about three months after these eggs have been thus deposited in the earth, the contained insect begins to break its shell, and a small grub or maggot crawls forth, and feeds upon the roots of whatever vegetable it happens to be nearest. All substances, of this kind, seem equally grateful, yet it is probable the mother insect has a choice among what kind of vegetables she shall deposit her young. In this manner these voracious creatures continue in the worm state, for more than three years, devouring the roots of every plant they approach, and

making their way under ground, in quest of food, with great dispatch and facility. At length they grow to above the size of a walnut, being a great thick white maggot with a red head, which is seen most frequently in new turned earth, and which is so eagerly sought after by birds of every species. When largest, they are found an inch and an half long, of a whitish yellow colour, with a body consisting of twelve segments or joints, on each side of which, there are nine breathing holes, and three red feet. The head is large, in proportion to the body, of a reddish colour, with a pincer before, and a semi-circular lip, with which it cuts the roots of plants, and sucks out their moisture. As this insect lives entirely under ground, it has no occasion for eyes, and accordingly it is found to have none; but is furnished with two feelers, which, like the crutch of a blind man, serve to direct its motions. Such is the form of this animal, that lives for years in the worm state under ground, still voracious, and every year changing its skin.

It is not till the end of the fourth year, that this extraordinary insect prepares to emerge from its subterraneous abode, and even this is not effected, but by a tedious preparation. About the latter end of autumn,
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the grub begins to perceive the approaches of its transformation, it then buries itself deeper and deeper in the earth, sometimes six feet beneath the surface, and there forms itself a capacious apartment, the walls of which it renders very smooth and shining, by the excretions of its body. Its abode being thus formed, it begins soon after, to shorten itself, to swell, and to burst its last skin, in order to assume the form of a chrysalis. This, in the beginning, appears of a yellowish colour, which heightens by degrees, till at last, it is seen nearly red. Its exterior form plainly discovers all the vestiges of the future winged insect, all the fore parts being distinctly seen ; while behind, the animal seems as if wrapped in swaddling cloaths.

The young may-bug continues in this state for about three months longer, and it is not till the beginning of January, that the aurelia divests itself of all its impediments, and becomes a winged insect, completely formed. Yet still the animal is far from attaining its natural strength, health, and appetite. It undergoes a kind of infant imbecillity, and unlike most other insects, that the instant they become flies are arrived at their state of full perfection, the may-bug continues feeble and sickly. Its colour
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is much brighter than in the perfect animal, all its parts are soft, and its voracious nature seems for a while, to have entirely forsaken it. As the animal is very often found in this state, it is supposed, by those unacquainted with its real history, that the old ones, of the former season, have buried themselves for the winter, in order to revisit the sun the ensuing summer. But the fact is, the old one never survives the season, but dies, like all the other winged tribe of insects, from the severity of cold in winter.

About the latter end of May, these insects, after having lived for four years under ground, burst from the earth, when the first mild evening invites them abroad. They are at that time seen rising from their long imprisonment, from living only upon roots, and imbibing only the moisture of the earth, to visit the mildness of the summer air, to chuse the sweetest vegetables for their banquet, and to drink the dew of the evening. Wherever an attentive observer then walks abroad, he will see them bursting up before him in his pathway, like ghosts on a theatre. He will see every part of the earth, that had its surface beaten into hardness, perforated by their egression. When the season is favourable for them, they are seen by myriads buzzing

buzzing along, hitting against every object that intercepts their flight. The mid-day sun, however, seems too powerful for their constitutions; they then lurk under the leaves and branches of some shady tree; but the willow seems particularly, their most favourite food; there they lurk in clusters, and seldom quit the tree till they have devoured all its verdure. In those seasons, which are favourable to their propagation, they are seen in an evening as thick as flakes of snow, and hitting against every object with a sort of capricious blindness. Their duration, however, is but short, as they never survive the season. They begin to join shortly after they have been let loose from their prison, and when the female is impregnated, she cautiously bores a hole in the ground, with an instrument fitted for that purpose, which she is furnished with at the tail, and there deposits her eggs, generally to the number of three score. If the season and the soil be adapted to their propagation, these soon multiply as already described, and go through the noxious stages of their contemptible existence. This insect, however, in its worm state, though prejudicial to man, makes one of the chief repasts of the feathered tribe, and is generally the first nourishment with which they supply

ply their young. Rooks, and hogs are particularly fond of these worms, and devour them in great numbers. The inhabitants of the county of Norfolk, some time since, went into the practice of destroying their rookeries, but in proportion, as they destroyed one plague, they were pestered with greater; and these insects multiplied in such an amazing abundance, as to destroy not only the verdure of the fields, but even the roots of vegetables, not yet shot forth. One farm in particular was so injured by them in the year 1750, that the occupier was not able to pay his rent, and the landlord was not only content to lose his income for that year, but also gave money for the support of the farmer and his family. In Ireland they suffered so much by these insects, that they came to a resolution of setting fire to a wood, of some miles in extent, to prevent their mischievous propagation.

Of all the beetle kind this is the most numerous, and therefore deserves the chief attention of history. The numerous varieties of other kinds, might repay the curiosity of the diligent observer, but we must be content in general to observe, that in the great out-lines of the history, they resemble those of which we have just been giving a description; like them, all other beetles are bred from

from the egg, which is deposited in the ground, or sometimes, tho' seldom, in the barks of trees, they change into a worm; they subsist in that state by living upon the roots of vegetables, or the succulent parts of the bark round them. They generally live a year at least before they change into an aurelia; in that state they are not entirely motionless, nor intirely swaddled up without form.

It would be tedious and endless to give a description of all, and yet it would be an unpardonable omission not to mention the particularities of some beetles, which are singular rather from their size, their manners, or their formation. That beetle which the Americans call the tumble-dung, particularly demands our attention; it is all over of a dusky black, rounder than those animals are generally found to be, and so strong, tho' not much larger than the common black beetle, that if one of them be put under a brass candlestick, it will cause it to move backwards and forwards, as if it were by an invisible hand, to the admiration of those who are not accustomed to the sight; but this strength is given it for much more useful purposes than those of exciting human curiosity, for there is no creature more laborious, either in seeking subsistence, or
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in providing a proper retreat for its young. They are endowed with sagacity to discover subsistence by their excellent smelling, which directs them in flights to excrements just fallen from man or beast, on which they instantly drop, and fall unanimously to work in forming round balls or pellets thereof, in the middle of which they lay an egg. These pellets, in September, they convey three feet deep in the earth, where they lye till the approach of spring, when the eggs are hatched, and the insects find their way out of the earth by bursting through their nests. They assist each other with indefatigable industry, in rolling these globular pellets to the place where they are to be buried. This they are to perform with the tail foremost, by raising up their hinder part, and shoving along the ball with their hind-feet. They are always accompanied with other beetles of a larger size, and of a more elegant structure and colour. The breast of this is covered with a shield of a crimson colour, and shining like metal; the head is of the like colour, mixed with green, and on the crown of the head stands a shining black horn, bended backwards. These are called the kings of the beetles, but for what reason is uncertain, since they partake of the same dirty drudgery with the rest.

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The Elephant-beetle is the largest of this kind hitherto known, and is found in South-America, particularly Guiana and Surinam, as well as about the river Oroonoko. It is of a black colour, and the whole body is covered with a very hard shell, full as thick and as strong as that of a small crab. Its length, from the hinder part to the eyes, is almost four inches, and from the same part to the end of the proboscis, or trunk, four inches and three quarters. The transverse diameter of the body is two inches and a quarter, and the breadth of each elytron, or case for the wings, is an inch and three-tenths. The antennæ or feelers, are quite horny; for which reason the proboscis or trunk is moveable at its insertion into the head, and seems to supply the place of feelers. The horns are eight-tenths of an inch long, and terminate in points. The proboscis is an inch and a quarter long, and turns upwards, making a crooked line, terminating in two horns, each of which is near a quarter of an inch long; but they are not perforated at the end like the proboscis of other insects. About four-tenths of an inch above the head, or that side next the body, is a prominence, or small horn, which if the rest of the trunk were away, would cause this part to resemble the horn of a rhinoceros. There is indeed a beetle so called, but then
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the horns or trunk has no fork at the end, though the lower horn resembles this. The feet are all forked at the end, but not like lobsters claws.

To this class we may also refer the glow-worm, that little animal which makes such a distinguished figure in the descriptions of our poets. No two insects can differ more than the male and female of this species from each other. The male is in every respect a beetle, having cases to its wings, and rising in the air at pleasure; the female, on the contrary has none, but is entirely a creeping insect, and is obliged to wait the approaches of her capricious companion. The body of the female has eleven joints, with a shield breast-plate, the shape of which is oval; the head is placed over this, and is very small, and the three last joints of her body are of a yellowish colour; but what distinguishes it from all other animals, at least in this part of the world, is the shining light which it emits by night, and which is supposed by some philosophers, to be an emanation which she sends forth to allure the male to her company. Most travellers who have gone through sandy countries, must well remember the little shining sparks with which the ditches are studded on each side of the road. If incited by curiosity to approach

approach more nearly, he will find the light sent forth by the glow-worm; if he should keep the little animal for some time, its light continues to grow paler, and at last appears totally extinct: The manner in which this light is produced has hitherto continued inexplicable; it is probable the little animal is supplied with some electrical powers, so that by rubbing the joints of its body against each other, it thus supplies a stream of light, which if it allures the male, as we are told, serves for very useful purposes.

The cantharis is of the beetle kind, from whence comes cantharides, well known in the shops by the name of Spanish flies, and for their use in blisters. They have feelers like bristles, flexible cases to the wings, a breast pretty plain, and the sides of the belly wrinkled. Cantharides differ from each other in their size, shape, and colour, those used in the shops also do the same. The largest in these parts are about an inch long, and as much in circumference, but others are not above three quarters of an inch. Some are of a pure azure colour, others of pure gold, and others again, have a mixture of pure gold and azure colours; but they are all very brilliant, and extremely beautiful. These insects, as is well known, are of the greatest

greatest benefit to mankind, making a part in many medicines conducive to human preservation. They are chiefly natives of Spain, Italy, and Portugal; but they are to be met with also about Paris in the summer time, upon the leaves of the ash, the poplar, and the rose-trees, and also among wheat, and in meadows. It is very certain, that these insects are fond of ash leaves, inso-much that they will sometimes strip one of these trees quite bare. Some affirm, that these flies delight in sweet-smelling herbs, and it is very certain, that they are fond of honey-suckles, lilac, and wild-cherry shrubs; but some that have sought after them declare, they never could find them on elder-trees, nut-trees, and among wheat. We are told, that the country people expect the return of these insects every seven years. It is very certain, that such a number of these insects have been seen together in the air, that they appeared like swarms of bees; and that they have so disagreeable a smell, that it may be perceived a great way off, especially about sun-set, though they are not seen at that time. This bad smell is a guide for those who make it their business to catch them. When they are caught, they dry them, after which they are so light, that fifty will hardly weigh a dram. Those that
gather

gather them, tie them in a bag, or a piece of linen cloth, that has been well worn, and then they kill them with the vapours of hot vinegar, after which they dry them in the sun, and keep them in boxes. These flies, thus dried, being chymically analysed, yield a great deal of volatile caustic-salt, mixed with a little oil, phlegm and earth. Cantharides are penetrating, corrosive, and applied to the skin, raise blisters, from whence proceeds a great deal of serosity. They are made use of both inwardly and outwardly. However it is somewhat strange that the effects of these flies should fall principally upon the urinary passages, but though some authors have endeavoured to account for this, we are still in the dark, for all they have said amounts to no more, than that they affect these parts in a manner which may be very learnedly described, but very obscurely comprehended.

An insect of great, though perhaps not equal use in medicine, is that which is known by the name of the kermes; it is produced in the excrescence of an oak, called the berry-bearing ilex, and appears at first wrapt up in a membranaceous bladder, of the size of a pea, smooth and shining, of a brownish red colour, and covered with a very fine ash-coloured powder. This bag teems with
a number

a number of reddish eggs or insects, which being rubbed with the fingers pour out a crimson liquor. It is only met with in warm countries in the months of May and June. In the month of April this insect becomes of the size and shape of a pea, and its eggs some time after burst from the womb, and soon turning worms, run about the branches and leaves of the tree. They are of two sexes, and the females have been hitherto described; but the males are very distinct from the former, and are a sort of small flies like gnats, with six feet, of which the four forward are short, and the two backward long, divided into four joints, and armed with three crooked nails. There are two feelers on the head, a line and a half long, which are moveable, streaked and articulated. The tail, at the back part of the body, is half a line long, and forked. The whole body is covered with two transparent wings, and they leap about in the manner of fleas. The harvest of the kermes is greater or less in proportion to the severity of the winter, and the women gather them before sun-rising, tearing them off with their nails; for fear there should be any loss from the hatching of the insects. They sprinkle them with vinegar, and lay them in the sun to dry, where they acquire a red colour.

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An insect, perhaps, still more useful than either of the former, is the cochineal, which has been very variously described by authors; some have supposed it a vegetable excrescence from the tree upon which it is found; some have described it as a louse, some as a bug, and some as a beetle. As they appear in our shops when brought from America, they are of an irregular shape, convex on one side, and a little concave on the other; but are both marked with transverse streaks or wrinkles. They are of a scarlet colour within, and without of a blackish red, and sometimes of a white, reddish, or ash-colour, which are accounted the best, and are brought to us from Mexico. The cochineal insect is of an oval form, of the size of a small pea, with six feet, and a snout or trunk. It bring forth its young alive, and is nourished by sucking the juice of the plant. Its body consists of several rings, and when it is once fixed on the plant, it continues immoveable, being subject to no change. Some pretend there are two sorts, the one domestic, which is best, and the other wild, that is of a vivid colour; however they appear to be the same, only with this difference, that the wild feeds upon uncultivated trees, without any assistance, whereas the domestic is carefully at a stated

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season, removed to cultivated trees, where it feeds upon a purer juice. Those who take care of these insects, place them on the prickly pear-plant in a certain order and are very industrious in defending them from other insects; for if any other kind come among them, they take care to brush them off with foxes tails. Towards the end of the year, when the rains and cold weather are coming on, which are fatal to these insects, they take off the leaves or branches covered with cochineal, that have not attained their utmost degree of perfection, and keep them in their houses till winter is past. These leaves are very thick and juicy, and supply them with sufficient nourishment, while they remain within doors. When the milder weather returns, and these animals are about to exclude their young, the natives make them nests, like those of birds, but less, of tree-moss, or soft hay, or the down of cocoa-nuts, placing twelve in every nest. These they fix on the thorns of the prickly pear-plant, and in three or four days time they bring forth their young, which leave their nests in a few days, and creep upon the branches of the plant, till they find a proper place to rest in, and take in their nourishment; and until the females are fecundated by the males, which, as
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in the former tribe, differ very widely, from the females being winged insects, whereas the others only creep, and are at most stationary. When they are impregnated, they produce a new offspring, so that the propagator has a new harvest thrice a year. When the native Americans have gathered the cochineal, they put them into holes in the ground, where they kill them with boiling water, and afterwards dry them in the sun, or in an oven, or lay them upon hot plates. From the various methods of killing them, arise the different colours which they appear in when brought to us. When they are living, they seem to be sprinkled over with a white powder, which they lose as soon as the boiling water is poured upon them. Those that are dried upon hot places are the blackest. What we call the cochineal are only the females, for the males are a sort of fly, as already observed in the kermes. They are used both for dyeing and medicine, and are said to have much the same virtue as the kermes, tho' they are now seldom used alone, but are mixed with other things for the sake of the colour.

I shall end this account of the beetle tribe with the history of an animal which cannot properly be ranked under this species, and yet which cannot be more methodically

ranged under any other. This is the insect that forms and resides in the gall-nut, the spoils of which are converted to such useful purposes. The gall insects are bred in a sort of bodies adhering to a kind of oak in Asia, which differ with regard to their colour, size, roughness, smoothness and shape, and which we call galls. They are not fruit, as some have imagined, but preternatural tumours, owing to the wounds given to the buds, leaves, and twigs of the tree, by a kind of insects that lay their eggs within them. This animal is furnished with an implement, by which the female penetrates into the bark of the tree, or into that spot which just begins to bud, and there sheds a drop of corrosive fluid into the cavity. Having thus formed a receptacle for her eggs, she deposits them in the place, and dies soon after. The heart of the bud being thus wounded, the circulation of the nutritive juice is interrupted and the fermentation thereof, with the poison injected by the fly, burns the parts adjacent, and then alters the natural colour of the plant. The juice or sap turned back from its natural course, extravasates and flows round the egg. After which it swells and dilates by the assistance of some bubbles of air, which get admission through the pores of the bark, and which run in the vessels with the sap.

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The external coat of this excrescence is dried by the air, and grows into a figure which bears some resemblance to the bow of an arch, or the roundness of a kernel. This little ball receives its nutriment, growth and vegetation as the other parts of the tree by slow degrees, and is what we call the gall-nut. The worm that is hatched under this spacious vault, finds in the substance of the ball, which is as yet very tender, a subsistence suitable to its nature; gnaws and digests it till the time comes for its transformation to a nymph, and from that state of existence changes into a fly. After this the insect, perceiving itself duly provided with all things requisite, disengages itself soon from its confinement, and takes its flight into the open air. The case however, is not similar with respect to the gall-nut, that grows in autumn. The cold weather frequently comes on before the worm is transformed into a fly, or before the fly can pierce through its inclosure. The nut falls with the leaves, and altho' you may imagine that the fly which lies within is lost, yet in reality it is not so; on the contrary, its being covered up so close, is the means of its preservation. Thus it spends the winter in a warm house, where every crack and cranny of the nut is well stopped up; and lies buried as it were under a heap
of

of leaves, which preserves it from the injuries of the weather. This apartment, however, tho' so commodious a retreat in the winter, is a perfect prison in the spring. The fly, rouzed out of its lethargy by the first heats, breaks its way through, and ranges where it pleases. A very small aperture is sufficient, since at this time the fly is but a diminutive creature. Besides, the ringlets whereof its body is composed, dilate, and become pliant in the passage.



C H A P. VII.

Of the Gnat and the Tipula.

THERE are two insects which entirely resemble each other in their form, and yet widely differ in their habits, manners and propagation. Those who have seen the tipula, or long-legs, and the larger kind of gnat, have most probably mistaken the one for the other, they have often accused the tipula, a harmless insect, of depredations made by the gnat, and the innocent have suffered for the guilty; indeed the differences in their form are so very minute, that it often requires the assistance of a microscope to distinguish the one from the other: they are both mounted on long legs, both furnished with two wings and a slender body; their heads are large, and they seem to be hump-backed; the chief and only difference, therefore, is, that the tipula wants a trunk, while the gnat has a large one, which it often exerts to very mischievous purposes. The tipula is a harmless peaceful insect, that offers injury to nothing; the gnat is sanguinary and predaceous, ever seeking out for a place in which to bury its trunk, and pump-
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ing up the blood from the animal in large quantities.

The gnat proceeds from a little worm, which is usually seen at the bottom of standing waters. The manner in which the insect lays its eggs is particularly curious; after having laid the proper number on the surface of the water, it surrounds them with a kind of unctuous matter, which prevents them from sinking; but at the same time fastens them with a thread to the bottom, to prevent their floating away, at the mercy of every breeze, from a place the warmth of which is proper for their production, to any other, where the water may be too cold, or the animals its enemies too numerous. Thus the insects, in their egg state, resemble a buoy, which is fixed by an anchor. As they come to maturity they sink deeper, and at last, when they leave the egg as worms they creep at the bottom. They now make themselves lodgments of cement, which they fasten to some solid body at the very bottom of the water, unless, by accident, they meet with a piece of chalk, which being of a soft and pliant nature, gives them an opportunity of sinking a retreat for themselves, where nothing but the claws of a crayfish can possibly molest them. The worm afterwards

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afterwards changes its form. It appears with a large head, and a tail invested with hair, and moistened with an oleaginous liquor, which she makes use of as a cork, to sustain her head in the air, and her tail in the water, and to transport her from one place to another. When the oil in which her tail is moistened begins to grow dry, she discharges out of her mouth an unctuous humour, which she sheds all over her tail, by virtue whereof, she is enabled to transport herself where she pleases, without being either wet or any ways incommoded by the water. The gnat, in her second state, is properly speaking, in her form of a nymph, which is an introduction, or entrance into a new life. In the first place, she divests herself of her second skin; in the next she resigns her eyes, her antennæ, and her tail; in short, she actually seems to expire. However, from the spoils of the amphibious animal, a little winged insect cuts the air, whose every part is active to the last degree, and whose whole structure is the just object of our admiration. Its little head is adorned with a plume of feathers, and its whole body invested with scales and hair, to secure it from any wet or dust. She makes trial of the activity of her wings, by rubbing them either against her body, or her broad side-bags,

bags, which keep her in an equilibrium. The furbelow, or little border of fine feathers, which graces her wings is very curious, and strikes the eye in the most agreeable manner. There is nothing, however, of greater importance to the gnat, than her trunk, and that weak implement may justly be deemed one of nature's master-pieces. It is so very small, that the extremity of it can scarcely be discerned through the best microscope that can be procured. That part which is at first obvious to the eye, is nothing but a long scaly sheath under the throat. At near the distance of two thirds of it, there is an aperture, through which the insect darts out four stings, and afterwards retracts them. One of which, however sharp and active it may be, is no more than the case in which the other three lie concealed, and run in a long groove. The sides of these stings are sharpened like two-edged swords; they are likewise barbed, and have a vast number of cutting teeth towards the point, which turns up like a hook, and is fine beyond expression. When all these darts are stuck into the flesh of animals, sometimes one after another, and sometimes all at once, the blood and humours of the adjacent parts must unavoidably be extravasated; upon which a tumour must consequently ensue, the little orifice
whereof

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whereof is closed up by the compression of the external air. When the gnat, by the point of her case, which she makes use of as a tongue, has tasted any fruit, flesh, or juice, that she has found out; if it be a fluid, she sucks it up, without playing her darts into it; but in case she finds the least obstruction by any flesh whatever, she exerts her strength, and pierces through it, if possibly she can. After this she draws back her stings into their sheath, which she applies to the wound in order to extract, as through a reed, the juices which she finds inclosed. This is the implement with which the gnat performs her work in the summer, for during the winter she has no manner of occasion for it. Then she ceases to eat, and spends all that tedious season either in quarries or in caverns, which she abandons at the return of summer, and flies about in search after some commodious ford, or standing water, where she may produce her progeny, which would be soon washed away and lost, by the too rapid motion of any running stream. The little brood are sometimes so numerous, that the very water is tinged according to the colour of the species, as green, if they be green, and of a sanguine hue, if they be red.

These

These are circumstances sufficiently extraordinary in the life of this little animal, but it offers something still more curious in the method of its propagation. However similar insects of the gnat kind are in their appearance, yet they differ widely from each other in the manner in which they are brought forth, for some are oviparous, and are produced from eggs, some are viviparous, and come forth in their most perfect form; some are males, and unite with the female; some are females, requiring the impregnation of the male; some are of neither sex, yet still produce young, without any copulation whatsoever. This is one of the strangest discoveries in all natural history! A gnat separated from the rest of its kind, and inclosed in a glass vessel, with air sufficient to keep it alive, shall produce young, which also, when separated from each other, shall be the parents of a numerous progeny. Thus, down for five or six generations do these extraordinary animals propagate without the use of copulation, without any congress between the male and female, but in the manner of vegetables, the young bursting from the body of their parents, without any previous impregnation. At the sixth generation however, their propagation stops, the gnat no longer produces its like, from itself
alone,

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alone, but it requires the access of the male to give it another succession of fecundity.

The gnat of Europe gives but little uneasiness; it is sometimes heard to hum about our beds at night, and keeps off the approaches of sleep by the apprehension it causes; but it is very different in the ill-peopled regions of America, where the waters stagnate, and the climate is warm, and where they are produced in multitudes beyond expression. The whole air is there filled with clouds of those famished insects; and they are found of all sizes, from six inches long, to a minuteness that even requires the microscope to have a distinct perception of them. The warmth of the mid-day sun is too powerful for their constitutions; but when the evening approaches, neither art nor flight can shield the wretched inhabitants from their attacks, though millions are destroyed, still millions more succeed, and produce unceasing torment. The native Indians, who anoint their bodies with oil, and who have from their infancy been used to their depredations, find them much less inconvenient than those who are newly arrived from Europe; they sleep in their cottages covered all over with thousands of the gnat kind upon their bodies, and yet do not seem to have their slumbers interrupted by their
cruel

cruel devourers. If a candle happens to be lighted in one of those places, a cloud of insects at once light upon the flame, and extinguish it; they are therefore obliged to keep their candles in glass lanthorns; a miserable expedient to prevent an unceasing calamity.



PART

PART V.

P A R T V

C H A P. VIII.

Of Zoophytes in General.

WE are now come to the last link in the chain of animated nature, to a class of beings so confined in their powers, and so defective in their formation, that some historians have been at a loss whether to consider them as a superior rank of vegetables, or the humblest order of the animated tribe. In order therefore to give them a denomination, agreeable to their existence, they have been called Zoophytes, a name implying vegetable nature indued with animal life; and indeed, in some the marks of the animal are so few, that it is difficult to give their place in nature with precision, or to tell whether it is a plant or an insect that is the object of our consideration.

Should it be asked what it is that constitutes the difference between animal and vegetable life, what it is that lays the line that separates those two great kingdoms from each other, it would be difficult, perhaps we should find it impossible, to return an answer. The power of motion cannot form this distinction, since some vegetables are possess of motion, and many animals are

totally without it. The sensitive plant has obviously a greater variety of motions than the oyster or the pholas. The animal that fills the acorn-shell is immoveable, and can only close its lid to defend itself from external injury, while the flower, which goes by the name of the fly-trap, seems to close upon the flies that light upon it, and that attempt to rifle it of its honey. The animal in this instance, seems to have scarce a power of self-defence; the vegetable not only guards its possessions, but seizes upon the robber that would venture to invade them. In like manner, the methods of propagation give no superiority to the lower rank of animals. On the contrary, vegetables are frequently produced more conformably to the higher ranks of the creation, and though some plants are produced by cuttings from others, yet the general manner of propagation is from seeds, laid in the womb of the earth, where they are hatched into the similitude of the parent plant or flower. But a most numerous tribe of animals have lately been discovered, which are propagated by cuttings, and this in so extraordinary a manner, that, though the original insect be divided into a thousand parts, each, however small, shall be formed into an animal, entirely resembling that which was at first divided;

divided; in this respect, therefore, certain races of animals seem to fall beneath vegetables, by their more imperfect propagation.

What, therefore, is the distinction between them, or are the orders so intimately blended as that it is impossible to mark the boundaries of each? To me it would seem, that all animals are possessed of one power, of which vegetables are totally deficient; I mean either the actual ability, or an awkward attempt at self-preservation. However vegetables may seem possessed of this important quality, yet it is with them but a mechanical impulse, resembling the raising one end of the lever, when you depress the other; the sensitive plant contracts and hangs its leaves, indeed, when touched, but this motion no way contributes to its safety; the fly-trap flower acts entirely in the same manner; and though it seems to seize the little animal, that comes to annoy it, yet in reality, only closes mechanically upon it, and this inclosure neither contributes to its preservation nor its defence. But it is very different with insects, even of the lowest order; the earth-worm not only contracts, but hides itself in the earth, and escapes with some share of swiftness from its pursuers. The polypus hides its horns; the star-fish contracts its arms, upon the ap-

pearance even of distant dangers; they not only hunt for their food, but provide for their safety, and however imperfectly they may be formed, yet still they are in reality, placed many degrees above the highest vegetable of the earth, and are possessed of many animal functions, as well as those that are more elaborately formed.

But though these be superior to plants, they are very far beneath their animated fellows of existence. In the class of zoophytes, we may place all those animals, which may be propagated by cuttings, or in other words, which, if divided into two or more parts, each part in time, becomes a separate and perfect animal; the head shoots forth a tail, and on the contrary, the tail produces a head; some of these will bear dividing, but into two parts, such is the earth-worm; some may be divided into more than two, and of this kind are many of the star fish; others still may be cut into a thousand parts, each becoming a perfect animal; they may be turned inside out, like the finger of a glove, they may be moulded into all manner of shapes, yet still their vivacious principle remains, still every single part becomes perfect in its kind, and after a few days existence, exhibits all the arts and industry

dustry of its contemptible parent! We shall, therefore, divide zoophytes according to their several degrees of perfection, namely, into worms, star-fish and polypi; contenting ourselves with a short review of those nauseous and despicable creatures, that excite our curiosity chiefly by their imperfections; it must not be concealed, however, that much has of late been written on this part of natural history. A new mode of animal production, could not fail of exciting not only the curiosity, but the astonishment of every philosopher; many found their favourite systems totally overthrown by the discovery, and it was not without a wordy struggle, that they gave up what had formerly been their pleasure and their pride. At last, however, conviction became too strong for argument, and a question, which owed its general spread rather to its novelty, than to its importance, was given up in favour of the new discovery.



C H A P. IX.

Of Worms.

THE first in the class of zoophytes, are animals of the worm kind, which being entirely destitute of feet, trail themselves along upon the ground, and find themselves a retreat under the earth, or in the water. As these, like serpents, have a creeping motion, so both, in general, go under the common appellation of reptiles; a loathsome, noxious, malignant tribe, to which man by nature, as well as by religion, has the strongest antipathy. But though worms, as well as serpents, are mostly without feet, and have been doomed to creep along the earth on their bellies, yet their motions are very different. The serpent, as has been said before, having a back bone, which it is incapable of contracting, bends its body into the form of a bow, and then shoots forward from the tail; but it is very different with the worm, which has a power of contracting or lengthening itself at will. There is a spiral muscle, that runs round its whole body, from the head to tail, somewhat resembling a wire wound round a walking-cane, which
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when slipped off, and one end extended and held fast, will bring the other nearer to it; in this manner the earth-worm, having shot out, or extended its body, takes hold by the slime of the fore part of its body, and so contracts and brings forward the hinder part; in this manner it moves onward, not without great effort, but the occasions for progressive motion are few.

As it is designed for living under the earth, and leading a life of obscurity, so it seems tolerably adapted to its situation. Its body is armed with small stiff sharp burrs or prickles, which it can erect or depress at pleasure; under the skin there lies a slimy juice, to be ejected as occasion requires, at certain perforations, between the rings of the muscles, to lubricate its body, and facilitate its passage into the earth. Like most other insects, it hath breathing-holes along the back, adjoining each ring; but it is without bones, without eyes, without ears, and, properly without feet. It has a mouth, and also an elementary canal, which runs along to the very point of the tail. In some worms, however, particularly such as are found in the bodies of animals, this canal opens towards the middle of the belly, at some distance from the tail. The intestines of the earth-worm, are always found filled with

with a very fine earth, which seems to be the only nourishment these animals are capable of receiving.

The animal is entirely without brain, but near the head is placed the heart, which is seen to beat with a very distinct motion, and round it are the spermatic vessels, forming a number of little globules, containing a milky fluid, which have an opening into the belly, not far from the head: they are also often found to contain a number of eggs, which are laid in the earth, and are hatched in twelve or fourteen days into life, by the genial warmth of their situation; like snails, all these animals unite in themselves, both sexes at once, the reptile that impregnates, being impregnated in turn; few that walk out, but must have observed them, with their heads laid against each other, and so strongly attached, that they suffer themselves to be trod upon.

When the eggs are laid in the earth, which, in about fourteen days, as has been said, are hatched into maturity, the young ones come forth very small, but perfectly formed, and suffer no change during their existence: how long their life continues is not well known, but it certainly holds for more than two or three seasons. During the winter

winter they bury themselves deeper in the earth, and seem, in some measure, to share the general torpidity of the insect tribe. In spring, they revive with the rest of nature, and on those occasions, a moist or dewy evening brings them forth from their retreats, for the universal purpose of continuing their kind. They chiefly live in a light rich and fertile soil, moistened by dews or accidental showers, but avoid those places where the water is apt to lie on the surface of the earth, or where the clay is too stiff for their easy progression under ground.

Helpless as they are formed, yet they seem very vigilant in avoiding those animals that chiefly make them their prey; in particular the mole, who feeds entirely upon them beneath the surface, and who seldom ventures, from the dimness of its sight, into the open air; him they avoid, by darting up from the earth, the instant they feel the ground move; and fishermen, who are well acquainted with this, take them in what numbers they chuse, by stirring the earth where they expect to find them. They are also driven from their retreats under ground, by pouring bitter or acrid water thereon, such as that water in which green walnuts have been steeped, or a lye made of pot-ashes.

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Such is the general outline of the history of these reptiles, which, as it should seem, degrades them no way beneath the rank of other animals of the insect creation; but we now come to a part of their history, which proves the imperfection of their organs, from the easiness with which these little machines may be damaged and repaired again. It is well known in mechanics, that the finest and most complicated instruments are the most easily put out of order, and the most difficultly set right; the same also obtains in the animal machine. Man, the most complicated machine of all others, whose nerves are more numerous, and powers of action more various, is most easily destroyed: he is seen to die under wounds which a quadruped or a bird could easily survive; and as we descend gradually to the lower ranks, the ruder the composition, the more difficult it is to disarrange it. Some animals live without their limbs, and often are seen to reproduce them; some are seen to live without their brain for many weeks together; caterpillars continue to increase and grow large, though all their nobler organs are intirely destroyed within; some animals continue to exist, though cut in two, their nobler parts preserving life, while the others perish that were cut away; but the earth worm, and all the
zoophyte

zoophyte tribe, continue to live in separate parts, and one animal, by the means of cutting, is divided into two distinct existences, sometimes into a thousand.

There is no phænomenon in all natural history more astonishing than this, that man, at pleasure, should have a kind of creative power, and out of one life make two, each compleatly formed, with all its apparatus and functions, each with its perceptions, and powers of motion and self-preservation, each as compleat in all respects as that from which it derived its existence, and equally enjoying the humble gratifications of its nature.

When De Cartes first started the opinion, that brutes were machines, the discovery of this surprizing propagation was unknown, which might, in some measure, have strengthened his fanciful theory. What is life, in brutes, he might have said, or where does it reside? In some we find it so diffused, that every part seems to maintain a vivacious principle, and the same animal appears possessed of a thousand distinct irrational souls at the same time. But let us not, he would say, give so noble a name to such contemptible powers, but rank the vivifying principle in these with the sap that rises in vegetables, or the moisture that contracts a cord, or the heat

heat that puts water into motion ! Nothing in fact, deserves the name of soul, but that which reasons, that which understands, and by knowing God, receives the marks of its currency, and is minted with the impresson of its great Creator.

Such might have been the speculations of this philosopher ; however, to leave theory, it will be sufficient to say that we owe the first discovery of this power of reproduction in animals to Mr. Trembley, who first observed it in the polypus, and after him, Spalanzani and others found it taking place in the earth-worm, the sea-worm, and several other ill-formed animals of a like kind, which were susceptible of this new mode of propagation. This last philosopher, has tried several experiments upon the earth-worm, many of which succeeded according to his expectation ; every earth-worm, however, did not retain the vivacious principle with the same obstinacy ; some, when cut in two, were entirely destroyed ; others survived only in the nobler part ; and while the head was living the tail entirely perished, and a new one was seen to arise from the extremity. But what was most surprising of all, in some, particularly in the small red-headed earth worm, both extremities survived the operation ; the head produced
a tail

a tail with the anus, the intestines, the annular muscles, and the prickly beards; the tail part, on the other hand, was seen to shoot forth the nobler organs, and in less than the space of three months sent forth a head, heart, with all the apparatus and instruments of generation. This part, as may easily be supposed, was produced much more slowly than the former, a new head taking above three or four months for its completion, a new tail being shot forth in less than as many weeks. Thus two animals, by dissection, were made out of one, each with their separate appetites, each endued with life and motion, and seemingly as perfect as that single animal from whence they derived their origin.

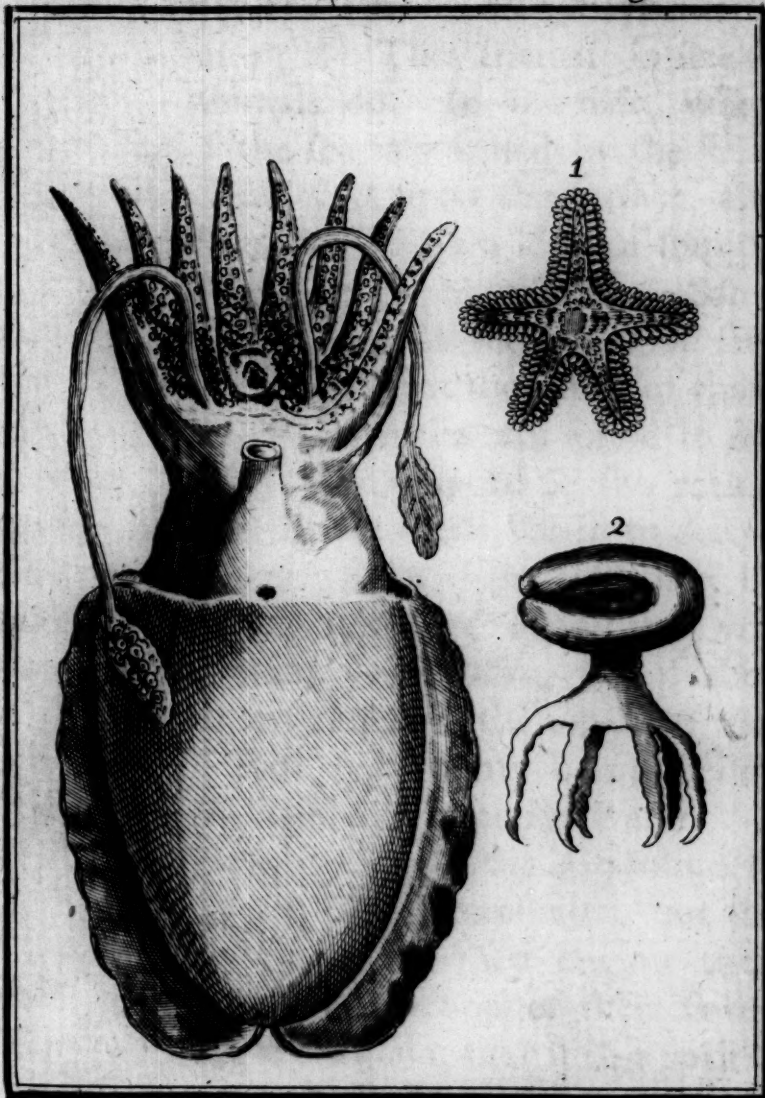
What was performed upon the earth-worm, was found to obtain also in many other of the vermicular species. The sea-worm, the white water-worm, and many of those little worms with feelers, found at the bottom of dirty ditches; in all these the nobler organs are of such little use, that if taken away, the animal does not seem to feel the want of them; it lives in all its parts, and in every part, and by a strange paradox in nature, the most useless and contemptible life is of all others the most difficult to destroy.

C H A P.

C H A P. X.

Of the Star-fish.

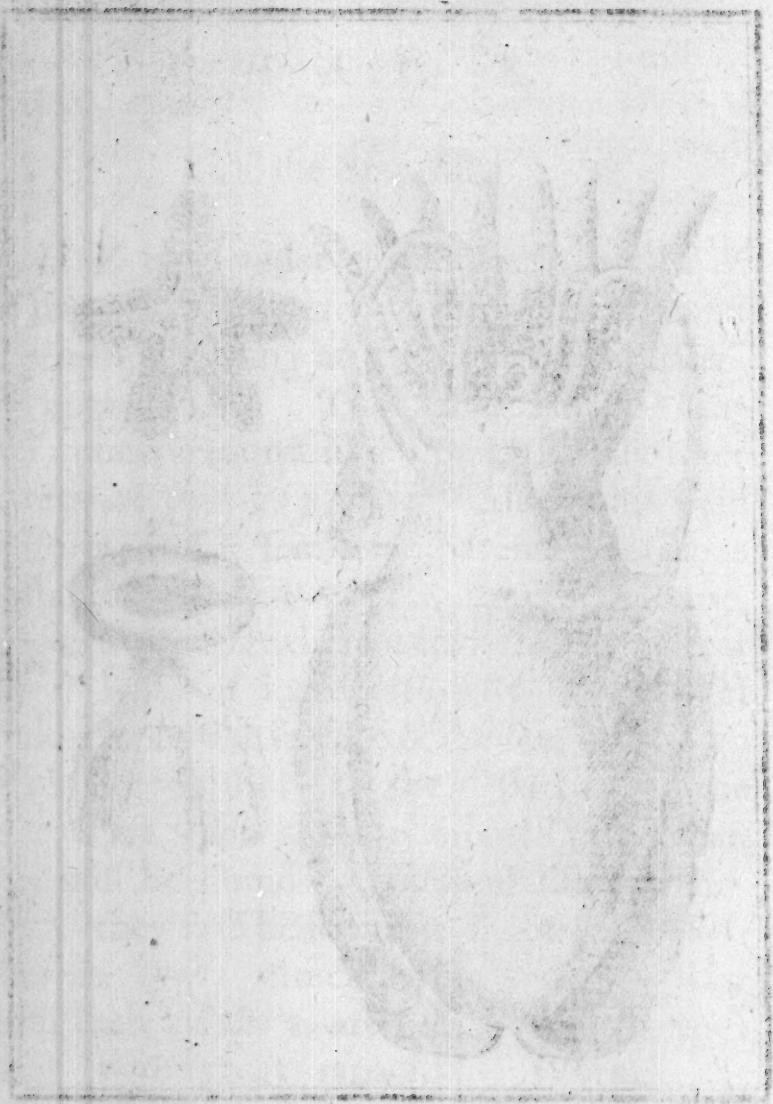
TH E next order of zoophytes is that of the star-fish, a numerous tribe, shapeless and deformed, assuming at different times different appearances. The same animal that now appears round like a ball, shortly after flattens as thin as a plate. All of this kind are formed of a semi-transparent gelatinous substance, covered with a thin membrane, and, to an inattentive spectator, often appear like a lump of inanimate jelly, floating at random upon the surface of the sea, or thrown by chance on shore at the departure of the tide. But upon a more minute inspection, they will be found possessed of life and motion ; they will be found to shoot forth their arms in every direction, in order to seize upon such insects as are near, and to devour them with great rapacity. Worms, the spawn of fish, and even muscles themselves, with their hard resisting shell, have been found in the stomachs of these voracious animals ; and what is very extraordinary, tho' the substance of their own bodies be almost as soft as water, yet they are no way injured by



The Cuttle Fish.

1 The Sea Star.

2 The Sea Nettle.



THEY WOULD
THEY WOULD
THEY WOULD

by fwallowing thefe fhells, which are almoft of a ftony hardnefs. They increafe in fize as all other animals do. In fummer, when the water of the fea is warmed by the heat of the fun, they float upon the furface, and in the dark they fend forth a kind of fhining light refembling that of phosphorus. Some have given thefe animals the name of fea-nettles, becaufe they burn the hands of thofe that touch them, as nettles are found to do. They are often feen faftened to the rocks, and to the largeft fea-fhells, as if to derive their nourifhment from them. If they be taken and put into fpirit of wine, they will continue for many years intire, but if they be left to the influence of the air, they are, in lefs than four and twenty hours melted down into a limpid and offensive water.

In all of this fpecies, none are found to poffefs a vent for their excrements, but the fame paffage by which they devour their food, ferves for the ejection of their fæces. Thefe animals as was faid, take fuch a variety of figures, that it is impoffible to describe them under one determinate fhape ; but in general, their bodies refemble a truncated cone, whose bafe is applied to the rock to which they are found ufually attached. Though generally transparent, yet they are found of different colours, fome inclining to
green,

green, some red, some white, and some to brown. In some, their colours appear diffused over the whole surface, in some, they are often streaked, and in others often spotted. They are possessed of a very slow progressive motion, and in fine weather, they are continually seen, stretching out and fishing for their prey. Many of them are possessed of a number of long slender filaments, in which they entangle any small animals they happen to approach, and thus draw them into their enormous stomachs, which fill the whole cavity of their bodies. The harder shells continue for some weeks indigested, but at length, they undergo a kind of maceration in the stomach, and become a part of the substance of the animal itself. The indigestible parts, are returned by the same aperture by which they were swallowed, and then the star-fish begins to fish for more. These also may be cut in pieces, and every part will survive the operation; each becoming a perfect animal, endued with its natural rapacity. Of this tribe, the number is various, and the description of each would be tedious and uninteresting, the manners and nature of all, are nearly as described; but I will just make mention of one creature, which, tho' not properly belonging to this class, yet

yet is so nearly related, that the passing it in silence would be an unpardonable omission.

Of all other animals, the cuttle-fish, tho' in some respect superior to this tribe, possesses qualities the most extraordinary. It is about two feet long, covered with a very thin skin, and its flesh composed of a gelatinous substance, which however within side is strengthened by a strong bone, of which such great use is made by the goldsmiths. It is possessed of eight arms, which it extends, and which are probably of service to it in fishing for its prey; while in life, it is capable of lengthening or contracting these at pleasure; but when dead, they contract and lose their rigidity. They feed upon small fish, which they seize with their arms; and they are bred from eggs, which are laid upon the weeds along the sea-shore.

The cuttle fish is found along many of the coasts of Europe, but are not easily caught, from a contrivance with which they are furnished by nature; this is a black substance, of the colour of ink, which is contained in a bladder generally on the left side of the belly, and which is ejected in the manner of an excrement from the anus. Whenever therefore this fish is pursued, and when it finds a difficulty of escaping, it spurts forth a great quantity of this black

liquor, by which the waters are totally darkened, and then it escapes, by lying close at the bottom. In this manner the creature finds its safety, and men find ample cause for admiration, from the great variety of stratagems with which creatures are endued for their peculiar preservation.



C H A P. XI.

Of the Polypus.

THOSE animals which we have described in the last chapter, are variously denominated. They have been called the Star-fish, Sea-nettles, and Sea-polypi. This last name has been peculiarly ascribed to them by the ancients, because of the number of feelers or feet of which they are all possessed, and with which they have a slow progressive motion; but the moderns have given the name of Polypus, to a reptile that lives in fresh water, by no means so large or observable. These are found at the bottom of wet ditches, or attached to the under surface of the broad-leaved plants that grow and swim on the waters. The same difference holds between these and the sea-water polypus, as between all the productions of the sea, and of the land and the ocean. The marine vegetables and animals grow to a monstrous size. The eel, the pike, or the bream of fresh-waters, is but small; but in the sea, they grow to an enormous magnitude. The herbs of the field are at most but a few feet high; those of the sea often shoot forth a stalk of a hundred. It is

so between the polypi of both elements. Those of the sea are found from two feet in length to three or four, and Pliny has even described one, the arms of which were no less than thirty feet long. Those in fresh waters, however, are comparatively minute; at their utmost size, seldom above three parts of an inch long, and when gathered up into their usual form, not above a third even of those dimensions.

It was upon these minute animals, that the power of dissection was first tried in multiplying their numbers. They had been long considered as little worthy the attention of observers, and were consigned to that neglect in which thousands of minute species of insects remain to this very day. It is true, indeed, that Reaumur observed, classed, and named them. By contemplating their motions, he was enabled distinctly to pronounce on their being of the animal, and not of the vegetable kingdom; and he called them Polypi, from their great resemblance to those larger ones that were found in the ocean. Still, however, their properties were neglected, and their history unknown.

Mr. Trembley was the person to whom we owe the first discovery of the amazing properties and powers of this little vivacious creature: He divided this class of animals
into

into four different kinds; into those inclining to green, those of a brownish cast, those of flesh-colour, those which he calls the polype *dé panache*. The differences of structure in these, as also of colour, are observable enough; but the manner of their subsisting, of seizing their prey, and of their propagation, is pretty nearly the same in all.

Whoever has looked with care into the bottom of a wet ditch, when the water is stagnant, and the sun has been powerful, may remember to have seen many little transparent lumps of jelly, about the size of a pea, and flattened on one side; such also as have examined the under side of the broad-leaved weeds that grow on the surface of the water, must have observed them studded with a number of these little jelly-like substances, which were probably then disregarded, because their nature and history was unknown. These little substances however, were no other than living polypi gathered up into a quiescent state and seemingly inanimate, because either disturbed, or not excited by the calls of appetite to action. When they are seen exerting themselves they put on a very different appearance from that when at rest; to conceive a just idea of their figure, we may suppose the finger of a glove cut off at the bottom; we may
suppose

suppose also several threads or horns planted round the edge like a fringe. The hollow of this finger will give us an idea of the stomach of the animal, the threads issuing forth from the edges may be considered as the arms or feelers, with which it hunts for its prey. The animal, at its greatest extent, is seldom seen above an inch and a half long, but it is much shorter when it is contracted and at rest; it is furnished neither with muscles nor rings, and its manner of lengthening or contracting itself, more resembles that of the snail, than worms, or any other insect. The polypus contracts itself more or less, in proportion as it is touched, or as the water is agitated in which they are seen. Warmth animates them, and cold benumbs them; but it requires a degree of cold approaching congelation before they are reduced to perfect inactivity; those of an inch have generally their arms double, often thrice as long as their bodies. The arms, where the animal is not disturbed, and the season not unfavourable, are thrown about in various directions, in order to seize and entangle its little prey; sometimes three or four of the arms are thus employed, while the rest are contracted like the horns of a snail, within the animal's body. It seems capable of giving what length it pleases to these arms; it contracts and extends them
at

at pleasure, and stretches them only in proportion to the remoteness of the object it would seize.

These animals have a progressive motion, which is performed by that power they have of lengthening and contracting themselves at pleasure; they go from one part of the bottom to another; they mount along the margin of the water, and climb up the side of aquatic plants. They often are seen to come to the surface of the water, where they suspend themselves by their lower end. As they advance but very slowly, they employ a great deal of time in every action, and bind themselves very strongly to whatever body they chance to move upon as they proceed; their adhesion is voluntary, and is probably performed in the manner of a cupping-glass applied to the body.

All animals of this kind have a remarkable attachment to turn towards the light, and this naturally might induce an enquirer to look for their eyes; but however carefully this search has been pursued, and however excellent the microscope with which every part was examined, yet nothing of the appearance of this organ was found over the whole body; and it is most probable that, like several other insects which hunt their prey by their feeling, these creatures
are

are unfurnished with advantages which would be totally useless for their support.

In the center of the arms, as was said before, the mouth is placed, which the animal can open and shut at pleasure, and this serves at once as a passage for food, and an opening for it after digestion. The inward part of the animal's body seems to be one great stomach, which is open at both ends; but the purposes which the opening at the bottom serves are hitherto unknown, but certainly not for excluding their excrements, for those are ejected at the aperture by which they are taken in. If the surface of the body of this little creature be examined with a microscope, it will be found studded with a number of warts, as also the arms, especially when they are contracted; and these tubercles, as we shall presently see, answer a very important purpose.

If we examine their way of living, we shall find these insects chiefly subsisting upon others, much less than themselves, particularly a kind of millepedes that live in the water, and a very small red worm, which they seize with great avidity. In short, no insect whatsoever, less than themselves, seems to come amiss to them; their arms, as was observed above, serve them as a
net

net would a fisherman, or perhaps more exactly speaking, as a lime-twigg does a fowler. Wherever their prey is perceived, which the animal effects by its feeling, it is sufficient to touch the object it would seize upon and it is fastened, without a power of escaping. The instant one of this insect's long arms is laid upon a millepede, the little insect sticks without a possibility of retreating. The greater the distance at which it is touched, the greater is the ease with which the Polypus brings the prey to its mouth. If the little object be near, tho' irretrievably caught, it is not without great difficulty that it can be brought to the mouth and swallowed. When the Polypus is unsupplied with prey, it testifies its hunger by opening its mouth; the aperture, however, is so small that it cannot be easily perceived; but when, with any of its long arms, it has seized upon its prey, it then opens the mouth distinctly enough, and this opening is always in proportion to the size of the animal which it would swallow; the lips dilate insensibly by small degrees, and adjust themselves precisely to the figure of their prey. Mr. Trembley, who took a pleasure in feeding this useless brood, found that they could devour aliments of every kind, fish and flesh as well as insects; but he owns they did not thrive so well upon beef and veal, as upon the little

the worms of their own providing. When he gave one of these famished reptiles any substance which was improper to serve for aliment, at first it seized the prey with avidity, but after keeping it some time entangled near the mouth, it let it drop again with distinguishing nicety.

When several polypi happen to fall upon the same worm, they dispute their common prey with each other. Two of them are often seen seizing the same worm at different ends, and dragging it at opposite directions with great force. It often happens that while one is swallowing its respective end, the other is also employed in the same manner, and thus they continue swallowing each his part, until their mouths meet together; they then rest, each for some time in this situation, till the worm breaks between them, and each goes off with his share; but it often happens, that a seemingly more dangerous combat ensues, when the mouths of both are thus joined upon one common prey together: the largest polypus then gapes and swallows his antagonist; but what is very wonderful, the animal thus swallowed seems to be rather a gainer by the misfortune. After it has lain in the conqueror's body for about an hour, it issues unhurt, and often in possession of the prey which had

had been the original cause of contention ; how happy would it be for men, if they had as little to fear from each other !

These reptiles continue eating the whole year, except when the cold approaches to congelation ; and then, like most others of the insect tribe, they feel the general torpor of nature, and all their faculties are for two or three months suspended ; but if they abstain at one time, they are equally voracious at another, and like snakes, ants, and other animals that are torpid in winter, the meal of one day suffices them for several months together. In general, however, they devour more largely in proportion to their size, and their growth is quick exactly as they are fed ; such as are best supplied, soonest acquire their largest size, but they diminish also in their growth with the same facility, if their food be taken away.

Such are the more obvious properties of these little animals, but the most wonderful still remain behind : Their manner of propagation, or rather multiplication, has for some years been the astonishment of all the learned of Europe. They are produced in as great a variety of manners as every species of vegetable. Some polypi are propagated from eggs, as plants are from their seed ;
some

some are produced by buds issuing from their bodies, as plants are produced by inoculation, while all may be multiplied by cuttings, and this to a degree of minuteness that exceeds even philosophical perseverance.

With respect to such of this kind as are hatched from the egg little curious can be added, as it is a method of propagation so common to all the tribes of insect nature; but with regard to such as are produced like buds from their parent stem, or like cuttings from an original root, their history requires a more detailed explanation. If a polypus be carefully observed in summer, when these animals are chiefly active, and more particularly prepared for propagation, it will be found to burgeon forth from different parts of its body several tubercles or little knobs, which grow larger and larger every day; after two or three days inspection, what at first appeared but a small excrescence takes the figure of a small animal, entirely resembling its parent, furnished with feelers, a mouth, and all the apparatus for seizing and digesting its prey. This little creature every day becomes larger, like the parent, to which it continues attached; it spreads its arms to seize upon whatever insect is proper for aliment, and devours it for its own particular benefit; thus it is possessed of two
sources

sources of nourishment, that which it receives from the parent by the tail, and that which it receives from its own industry by the mouth. The food which these animals receive often tinctures the whole body, and upon this occasion the parent is often seen communicating a part of its own fluids to that of its progeny that grows upon it; while, on the contrary, it never receives any tincture, from any substance that is caught and swallowed by its young. If the parent swallows a red worm, which gives a tincture to all its fluids, the young one partakes of the parental colour; but if the latter should seize upon the same prey, the parent polypus is no way benefited by the capture, but all the advantage remains with the young one.

But we are not to suppose that the parent is capable of producing only one at a time, several young ones are thus seen at once, of different sizes, growing from its body, some just budding forth, others acquiring their perfect form, and others come to sufficient maturity, and just ready to drop from the original stem to which they had been attached for several days. But what is more extraordinary still, those young ones themselves that continue attached to their
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parent, are seen to burgeon, and propagate their own young ones also, each holding the same dependance upon its respective parent, and possessed of the same advantages that have been already described in the first connection. Thus we see a surprizing chain of existence continued, and numbers of animals naturally produced without any union of the sexes, or other previous disposition of nature.

This seems to be the most natural way by which these insects are multiplied ; their production from the egg being not so common ; and tho' some of this kind are found with a little bladder attached to their bodies, which is supposed to be filled with eggs, which afterwards come to maturity, yet the artificial method of propagating these animals, is much more expeditious and equally certain : It is indifferent whether one of them be cut into ten, or ten hundred parts, each becomes as perfect an animal as that which was originally divided, but it must be observed, that the smaller the part which is thus separated from the rest, the longer it will be in coming to maturity, or in assuming its perfect form. It would be endless to recount the many experiments that have been tried upon this philosophical prodigy ;
the

the animal has been twisted, and turned in to all manner of shapes ; it has been turned inside out, it has been cut in every division, yet still it continued to move ; its parts adapted themselves again to each other, and in a short time it became as voracious and industrious as before.

Besides these kinds mentioned by Mr. Trembley, there are various others which have been lately discovered by the vigilance of succeeding observers, and some of these so strongly resembling a flowering vegetable in their forms, that they have been mistaken by many naturalists for such. Mr. Hughes, the author of the Natural History of Barbadoes, has described a species of this animal, but has mistaken its nature, and called it a sensitive flowering plant ; he observed it to take refuge in the holes of rocks, and when undisturbed, to spread forth a number of ramifications, each terminated by a flowery petal which shrunk at the approach of the hand, and withdrew into the hole from whence before it had been seen to issue. This plant however was no other than an animal of the polypus kind, which is not only to be found in Barbadoes, but also on many parts of the coast of Cornwall, and along the shores of the Continent.

C H A P.

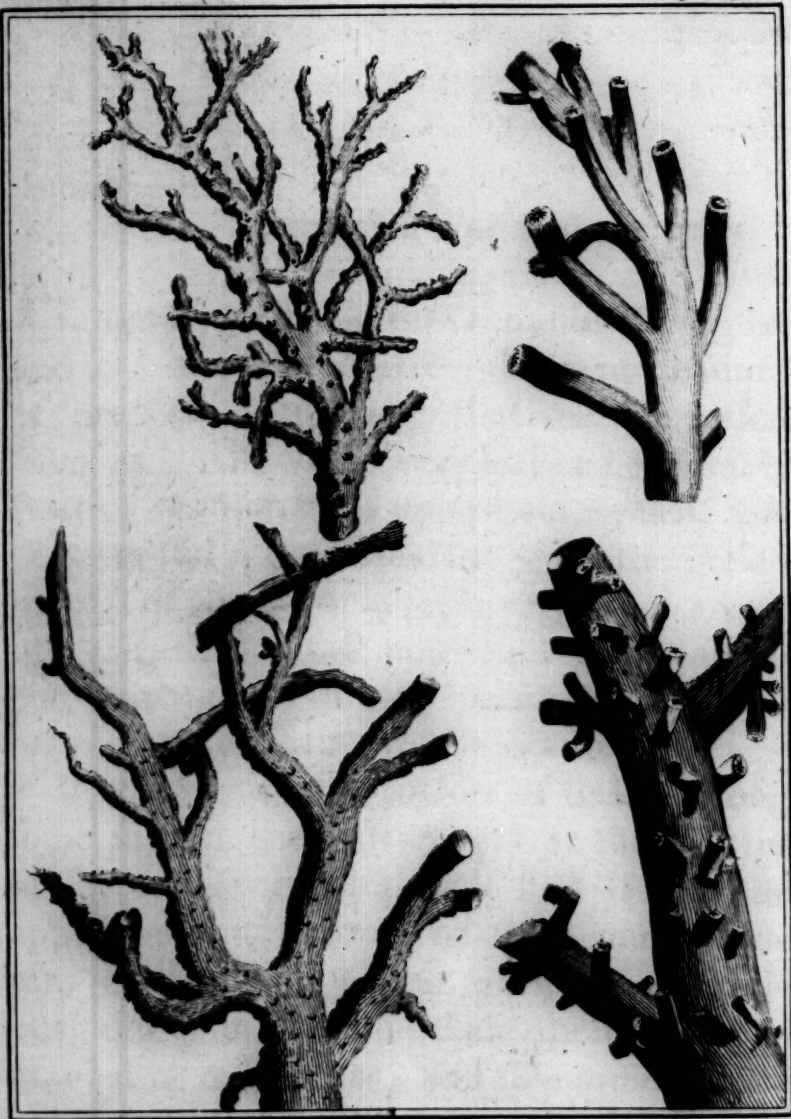
C H A P. XII.

Of Lithophytes and Sponges.

IT is very probable that the animals we see, and are acquainted with, bear no manner of proportion to those that are concealed from us. Although every leaf and vegetable swarms with animals upon land, yet at sea, they are still more abundant ; for the greatest part of what would seem vegetables growing there are in fact nothing but the artificial formation of insects, palaces which they have built for their own habitation.

If we examine the bottom of the sea along some shores, and particularly at the mouths of several rivers, we shall find it has the appearance of a forest of trees under water, millions of plants growing in various directions, with their branches entangled in each other, and sometime standing so thick as to obstruct navigation. The shores of the Persian gulph, the whole extent of the Red-sea, and the western coasts of America, are so choaked up in many places with these Coraline substances, that tho' ships

THE CHINESE



J. C. Lodge sculp.

The Coral-plants.

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ships force a passage through them, boats and swimmers find it impossible to make their way. These aquatic groves are formed of different substances, and assume various appearances. The coral-plants, as they are called, sometimes shoot out like trees without leaves in winter; they often spread out a broad surface like a fan, and not uncommonly a large bundling head, like a faggot; sometimes they are found to resemble a plant with leaves and flowers; and often the antlers of a stag, with great exactness and regularity. In other parts of the sea are seen sponges of various magnitude, and extraordinary appearances, assuming a variety of phantastic forms like large mushrooms, mitres, fonts and flower-pots. To an attentive spectator these various productions seem entirely of the vegetable kind; they seem to have their leaves and their flowers, and have been experimentally known to shoot out branches in the compass of a year. Philosophers, therefore, till of late, thought themselves pretty secure in ascribing these productions to the vegetable kingdom; and Count Marsigli, who has written very laboriously and learnedly upon the subject of corals and sponges, has not hesitated to declare his opinion, that they were plants of the aquatic kind, furnished with flowers,

feed, and endued with a vegetation intirely resembling that which is found upon land. This opinion, however, some time after, began to be shaken by Rhumphius and Jussieu, and at last by the ingenious Mr. Ellis, who by a more sagacious and diligent enquiry into nature, put it past doubt, that corals and sponges were entirely the work of animals and that like the honey-comb, which was formed by the bee, the coral was the work of an infinite number of reptiles of the polypus kind, whose united labours were thus capable of filling whole tracts of the ocean with those embarrassing tokens of their industry.

If in our researches after the nature of these plants, we should be induced to break off a branch of the coraline substance, and observe it carefully, we shall perceive its whole surface, which is very rugged and irregular, covered with a mucous fluid, and almost in every part studded with little jelly-like drops, which when closely examined, will be found to be no other than reptiles of the polypus kind. These have their motions, their arms, their appetites, exactly resembling those described in the last chapter, but they soon expire when taken out of the sea, and our curiosity is at once stopped in its career,

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career, by the animals ceasing to give any marks of their industry; recourse therefore has been had to other expedients, in order to determine the nature of the inhabitant, as well as the habitation.

If a coralline plant be strictly observed, while still growing in the sea, and the animals upon its surface be not disturbed, either by the agitation of the waters, or the touch of the observer, the little polypi will then be seen in infinite numbers, each issuing from its cell, and in some kinds, the head covered with a little shell, resembling an umbrella, the arms spread abroad, in order to seize its prey, while the hinder part still remains attached to its habitation, from whence it never wholly removes. By this time it is perceived that the number of inhabitants is infinitely greater than was at first suspected; that they are all assiduously employed in the same pursuits, and that they issue from their respective cells, and retire into them at pleasure. Still, however, there are no proofs that those large branches which they inhabit are entirely the construction of such feeble and minute animals. But chemistry will be found to lend a clue to extricate us from our doubts in this particular. Like the shells which are formed

by snails, muscles and oysters, these coralline substances effervesce with acids, and may therefore well be supposed to partake of the same animal nature. But Mr. Ellis went still farther, and examined their operations, just as they were beginning. Observing an oyster-bed which had been for some time neglected, he there perceived the first rudiments of a coralline plantation, and tufts of various kinds shooting from different parts of this favourable soil. It was upon these he tried his principal experiment. He took out the oysters which were thus furnished with coralines, and placed them in a large wooden vessel, covering them with sea-water. In about an hour, he perceived the animals, which before had been contracted by handling, and had shewn no signs of life, expanding themselves in every direction, and appearing employed in their own natural manner. Perceiving them therefore in this state, his next aim was to preserve them thus expanded, so as to be permanent objects of curiosity. For this purpose he poured, by slow degrees, an equal quantity of boiling water into the vessel of sea-water in which they were immersed. He then separated each polypus with pincers from its shell, and plunged each separately into small chrystal vases, filled with spirit
of

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of wine mixed with water. By this means, the animal was preserved entire, without having time to contract itself, and he thus perceived a variety of kinds, almost equal to that variety of productions, which these little animals are seen to form. He has been thus able to perceive and describe fifty different kinds, each of which is seen to possess its own peculiar mode of construction, and to form a coralline that none of the rest can imitate. It is true indeed, that on every coralline substance there are a number of polypi found, no way resembling those which are the erectors of the building; these may be called a vagabond race of reptiles, that are only intruders upon the labours of others, and that take possession of habitations, which they have neither art nor power to build for themselves. But in general, the same difference that subsists between the honeycomb of the bee, and the paper-like cells of the wasp, subsists between the different habitations of the coral-making polypi.

With regard to the various forms of these substances, they have obtained different names from the nature of the animal that produced them, or the likenesses they bear to some well known object, such as coralines fungimadrepores, sponges, astroites, and keratophytes.

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keratophytes. Tho' these differ extremely in their outward appearances, yet they all are formed in the same manner by reptiles of various kinds and nature. When examined chemically, they all discover the marks of animal formation; the corals, as was said, dissolve in acids, the sponges burn with an odour strongly resembling that of burnt horn. We are left somewhat at a loss with regard to the precise manner in which this multitude of cells, which at last assume the appearance of a plant or flower, are formed. If we may be led in this subject by analogy, it is most probable, that the substance of coral is produced in the same manner that the shell of the snail grows round it; these little reptiles are each possessed of a slimy matter, which covers its body, and this hardening, as in the snail, becomes an habitation exactly fitted to the body of the animal that is to reside in it; several of these habitations being joined together, form at length a considerable mass, and as most animals are productive, in proportion to their minuteness, so these multiplying in a surprising degree, at length form those extensive forests that cover the bottom of the deep.

Thus all nature seems replete with life; almost every plant on land has its surface covered with millions of these minute creatures,

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